LAND TEACHING

STOCKBRIDGE

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A Handbook of Soils, Plants, Gardens and Grounds, for Teachers and Cultivators

BY

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PREFACE

This little book has been prepared in the hope that it might aid in bringing the pupils of country schools close to the land.

Teachers should not be held wholly to blame if the instruction they give unfits for the life most of their pupils must live. Most teachers know that the majority of the school puplis of to-day must become the men and women of the farms to-morrow. They are not deliberately so educating them as to unfit them for success, or make them dissatisfied with farm life.

Teachers teach as best they may, with the knowledge they possess, the things the courses call for. The mere official introduction of the study of agriculture is but slight improvement. It would not be expected that a teacher ignorant of arithmetic should successfully teach arithmetic simply because the study was prescribed and textbooks furnished.

Yet this illustrates the present status of teaching agriculture in many schools.

Many teachers would gladly fit themselves for better work in this new field. Even agricultural colleges have hardly begun to meet the new demand, and few normal schools have yet recognized its existence. It is moreover, expecting too much to suppose that teachers shall immediately educate themselves for this new demand.

I am satisfied, however, that very many teachers would gladly welcome any source of information,—any practical guide or assistance,—which would enable them to do effective work in this distinctly rural field.

This is the demand I have tried to meet,—the help I now offer.

This book is not a textbook. It is not even a systematic presentation of any single subject. It is merely a source of information, the possession of which it is believed will enable teachers to teach successfully. Some of the principles of plant life, gardening, the fertilizing of crops, combatting plant pests, pruning, grafting, the ornamentation and care of school and home grounds, are the subjects presented.

Much of the material offered is rearranged from articles already published in the Southern Ruralist. Parts I, III and V were originally written by Professor T. H. McHatton, of the Georgia State College of

Agriculture, and Part IV by Professor H. P. Stuckey, of the Georgia Experiment Station.

The book has been prepared by teachers especially for the use of teachers. It is hoped, however, that it may prove of practical value to those who cultivate the soil. It is offered to the public in the sincere hope that it may help toward making the public school a more active agent in the advancement of rural life.

H. E. Stockbridge.

Atlanta, Ga., January, 1910.

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GREEN GRASS AND TREES.

PART I.

THE HOME GROUNDS.

Home! What a charm hangs around that name. It is never heard but that the mind flashes back for an instant to the by-gone days; may be to a palace, may be to a hut. How much more pleasant it is for that picture to be one of cleanliness, of flowers and green grass with the shadows of majestic trees cast on the carpet of the lawn, than to see tin cans, heaps of refuse, weeds and barren dirt, all in the blistering sun. It does not take much work to make the grounds about the house attractive. A few judiciously planted trees and shrubs will lend an air of refinement and repose to the most unsightly house. When we remember that within the home lies the foundation of the nation, is it not worth the while of patriotic mother and father to do everything within their power to brighten the ideals of the American people? Nothing so helps to mold youth into men or women of fine character as close contact with the beauties of Nature.

The homes of a country furnish the best index to the prosperity and moral tone of the community. There was once an old gentleman who traveled a good deal long before the time of railroads, and it was his custom, whenever he wished to stop for the night, always to pick out a house that had flowers and trees about it, for, as he said, he had no fear then of the kind of bed or food that he would get as he knew that it would be the best obtainable. If one stopped to think that most people, in passing a home, get a mental impression of the owner, would there not be many more beautiful homes than there are; for does not everyone wish his neighbor to think well of him?

Space will only allow us to throw out a few suggestions and leave each person to weave his or her individuallity into the surorundings of the home. The ideas given are simple: The plants practically all native, for after all, the local flora is generally the best adapted to use by the majority of people.

The General Idea—Green grass and trees always look well; if

there is not a flower or a shrub in sight the landscape is a joy to the eye, provided it shows soft lawns and waving trees. Green is most pleasing and restful to the sight. Had it not been so Nature would have used another color. The best lawn grass, from middle Georgia south is probably Bermuda; Kentucky Blue grass, also called June grass, is excellent where it can be used. White clover is often seen in lawns. It is objectionable, however, as it differs in color from the grasses and therefore gives a patchy appearance. It is good, nevertheless, to supplement grasses, cover bare spaces and make a quick lawn.

Deciduous Trees—It is best to have the deciduous trees in the planting predominate over the evergreens. There is nothing that adds so much to a home as a large tree near the house. It makes the building fit the landscape, and where the limbs extend over the roof it lends an air of protection and comfort to the picture. The easiest way to get this tree is to build under it, for it takes time to produce an old, weather-beaten, age-worn monarch. Some of the trees well adapted for home use are the hackberry or sugarberry (Celtis occidentalis L.), the various species of oak, the American elm (Ulmus Americana L.) and the maples. The poplars may also be used where a quick growing tree is desired. Some of them, however, such as the Lombardy, are very stiff and formal.

Evergreen Trees—About the best evergreen we have, though a very slow-growing tree, is the magnolia grandiflora. The live oak (Quercus Virginiana Mill) is also good where it can be used. Evergreens make a place somber; therefore should be used with care. The red cedar (Juniperus Virginia L) also makes a good tree. There are numerous others which need no mention. One or two evergreens judiciously placed help out the looks of things greatly during winter.

Hedges—These should rarely be used and never close to the house unless in a formal garden, and then they should be low. The greatest use of a hedge is to form a wind-break, which we do not need in the South, and, secondly, to shield unsightly objects, such as the barnyard, servants' house, etc. The common euonymus (Euonymus Japonicus L.) is quite a good hedge plant. Both the tree and the dwarf box may be used, the latter especially in formal gardens. Deodara (Cedra Deodara, Loud.) makes a good plant for a tall hedge and wind-break. Personally I am not a great advocate of hedges; in fact, think that a place can be made more beautiful without them.

Shrubs and Flowering Trees—A single specimen of euonymus, box tree or holly makes a good shrub. Azalia japonica may also be used when far enough south. The wild sweetshrub (Calycanthus Flodirus, L.) and the cultivated banana shrub, sometimes called sweetshrub, also add to a place. There are numberless barberries and spiraeas that can be used to advantage. Among the flowering trees may be mentioned the dogwood (Cornus Florida, I.), the lilacs, both white and purple. The latter, however, are generally considered shrubs. In some sections the flowering crabapple may be used to advantage and makes a beautiful tree for the lawn.

Flowers—First and foremost, do not cut the lawn up into geometrical beds. Flowers should be around the foundation of the house, or at least close to it; it is preferable to have a garden set aside in particular for them. A rose garden, at one side of the house and back of the lawn, is an unending source of pleasure. Flowers should be where they can be fertilized and worked. Like any other crop they need cultivation. It is needless for any special plants to be mentioned, as every one has his favorites. Besides, all flowers are pretty if not out of place. An old-fashioned garden is always attractive around a country home. Old maids and such other flowers of our grandmother's day always bring up thoughts of the past and create an atmosphere of reverie, in which one can spend an hour; or so with the greatest of profit and pleasure.

Conclusion—In conclusion, it may be said that there is nothing more beautiful than a natural tree or shrub, one that does not show tne work of man. Every tree and bush has its own individuality and grows in the fashion appointed by Nature. It is folly to try to make all trees round-headed by bobbing off their limbs and pruning them back to stumps. Let them grow as they list and then rejoice in the beautiful specimens that Nature will give you. A magnolia that has its limbs low to the ground far exceeds in beauty one that is pruned up ten or twelve feet. Remember that each plant is a problem unto itself, and if you seek long enough a kind Nature will let you find the answer as to the why and wherefore of its growth.

Part II.

FIRST PRINCIPLES.

The object of farming and gardening is to produce plants. Plants grow, they are living things; they grow by consuming food. This food comes from two sources, **soil and air.**

Agriculture, in its broadest sense, is the business of converting lifeless mineral matter of soil and air into living vegetable matter in the form of plants. It is founded, therefore, on the intelligent use of these materials. The properties of these two things should be understood by him who hopes to successfully influence their use.

I—THE SOIL.

Origin—The soil consists chiefly of fine particles of rocks. The original rocks were broken up and pulverized by action of several natural forces. The combined action of these forces is called **weathering.** Changes in temperature, earthquakes, running water, contraction of the earth's surface, glaciers, frost, the chemical action of water, air, and the action of animal and plant life, are the chief causes resulting in the disintegrating of rocks.

Mere pulverized rock, however is not soil. Before this mineral matter can become true soil capable of sustaining high plant life it must contain a certain amount of organic matter. This latter material must come from the decay of organized beings either animal or vegetable.

The simplest forms of plant life, like mosses and lichens, adhere to bare rock surfaces. By their death and decay a small quantity of vegetable matter becomes added to the weathering surface of the rock. Each generation of life adds to this accumulation. The surface of the rock continues to disintegrate and in time becomes covered with a thin layer of soil.

A true soil,—a mixture of mineral and organic materials,—is thus formed. The process continues with the lapse of time. As the

layer of soil increases the character of plants living on it changes till the highest forms of plant life appear, and the original rock is entirely buried beneath a depth of true soil capable of sustaining cultivated crops.

Composition of Soils—The actual amount of organic matter which must become incorporated with disintegrated rocks before true soil results is comparatively small. Certain cultivated plants, like rye and buckwheat, thrive on soils containing only 1 to 2 per cent. of organic matter.

Peat, or muck, has the highest proportion of organic matter, about 70 per cent. Fertile bottom lands contain from 10 to 12 per cent., while average soils contain about 6 per cent. of such material.

The entire organic part of soils is called **humus.** This contains several different acids one of the ingredients of which is nitrogen, which is an essential food of all plants. Humus, therefore, not only exerts great physical influence on soils, adapting them to the growth of plants, but is a source of actual plant food.

Properties of Soils—There are necessarily many properties, both physical and chemical, peculiar to soils. A few are of the utmost importonce in relation to the growth of crops.

Weight—This property varies greatly with different kinds of soils. The heaviest soils are those containing the most mineral (rock) material. The lightest ones are those containing the most organic, (vegetable) matter.

The weight of soils, therefore, is practically proportional to the mineral matter present.

The weight of 1 cubic foot of different kinds of soil is as follows:

Peat, 30 to 50 lbs.; Heavy clay, 75 lbs.; Loam, 78 lbs.; Average arable soil, 80 to 90 lbs.; Sandy clay, 96 lbs.; Sand, 110 lbs.

Structure and Color—The color influences soil chiefly as related to heat. Dark soils absorb heat, and, other things being equal, are warm sooner and remain warm longer than the same soils when light colored.

The structure of the soil is chiefly a matter of fineness of its particles. Other things being equal, the finer a soil the more fertile and more productive. It holds water better and dissolves plant food faster and more completely.

Soil and Water—Water is life to every living thing. Cultivated plants are practically capable of obtaining water only by means of their roots through the soil. The relations of different soils to water,

therefore, are of the most vital importance. The water capacity of soils varies greatly and determines to a great degree their crop producing power. It is controlled by the amount of air-space in a soil, or amount of room which water may occupy by driving out the air.

Common soils hold the following amounts of water: Sand 45.4 per cent.; clay, 50; loam, 60.1; peat, 63.7; average arable soil, 69.

The property of soils for allowing water to pass or percolate through them is called permeability. In common use this fact is called drainage.

This action is closely allied to **capillary action** which is the upward movement of soil water. In reality this is merely one manifestation of surface attraction. It is the movement of water upward from one soil particle to another. It is the same force manifested by the passage of oil through the lamp wick.

Permanent water exists at some depth in all soils. Wells always reach water if made deep enough. It is only a question of how deep? This fact is perhaps the most important in the whole realm of plant growth. It is this water moving upward to the surface by capillary action which supplies the demand of plants for life-giving water.

The nearer the soil particles are together the greater and more rapid is the movement of water between the particles. Therefore, capillary action is greater in compact soils and less in porous soils.

This fact gives the cultivator almost absolute control over the quantity of water available to crops. Cultivation, by making the surface soil more porous, interferes with capillary action. It prevents evaporation and waste from the surface soil into the air in time of drought.

The reverse of this practice, namely, allowing the soil to remain undisturbed when too wet, increases the capillary movement of water and hastens drying.

Soil and Heat—A certain amount of heat is necessary to all forms of life. Each plant grows only within certain limits of temperature of soil and water.

The heat of the soil comes from three different sources: **The Sun's Rays**, heat of **Chemical Action** or decomposition, and, least important, **Earth Heat** radiating from the moulten interior.

Except under very exceptional conditions the last source of heat is of little practical importance. The second source mentioned is of value in hot beds, but the heat derived from the sun is the only source of general interest.

Moisture and Heat—Water is converted into vapor by heat. The direct action of heat on soil water is to cause it to evaporate into the air. The greater the amount of water evaporated the greater the amount of heat used. This fact is largely responsible for the coldness of wet soils, since their heat is constantly being used for the evaporation of excess of water.

The soil is not a good conductor of heat, and air temperatures have comparatively slight influence on the soil.

Difference in heat of soil between day and night is but slight and is noticeable only to a depth of about 3 feet. Even differences between summer and winter in temperate climates penetrate only to a depth of about 70 feet.

The difference between the temperature of soil and air is of incalculable practical importance. This difference is due to the difference in the absorption of heat between soil and air.

The resulting difference in temperature is the direct cause of the formation of dew. Dew is simply vapor of water condensed by contact with a colder body and deposited as drops of water.

Contrary to common supposition the soil is the warmer substance and the air the colder. A thermometer placed just below the surface of the soil and then in the air just over the soil when the dew is being formed will show that the air is several degrees colder than the soil.

This fact is easily explained. During the day the soil absorbs heat from the sun. After sunset the air cools very quickly while the solid soil radiates heat slowly and therefore remains warm longer. Warm vapor of water evaporates from the warm soil and comes in contact with the overlying layer of cooler air. The immediate result is the condensation of this moisture and the formation of drops of dew.

The fact is that dew comes from the soil rather than from the air as formerly believed. The reason why crops do not suffer for moisture when dews are abundant is because soils furnishing water for such dew formation still contain water sufficient for the need of plants.

Kinds of Soil—The different kinds of soil used in common descriptions should be fixed in mind.

Sandy soil contains over 80 per cent. of actual sand. **Clay soil** contains not less than 60 per cent. of actual clay. **Loam** ranges between sand and clay. Each of these latter ingredients may predominate and be used in describing the particular soil in mind. Thus

sandy loam and clay loam are common terms. **Peat** or **muck** has the most humus of all soils. It contains the largest proportion of decomposed vegetation formed under water. Such soils are always wet till freed from this excess of water by drainage.

Gravel soil contains considerable quantities of unweathered bits of water-washed rock, together with varying proportions of fine earth up to 30 per cent. The larger this proportion the greater the agricultural value of this kind of soil.

Arable soil is the surface layer which is cultivated. **Subsoil** is the underlying layer penetrated by plant roots. **Hardpan** is the compact layer found beneath the subsoil. By pressure and chemical action it is again slowly assuming rock form.

Constant plowing at a certain depth is one of the most frequent causes of hardpan, the breaking of which by deeper or subsoil plowing is often necessary.

II—THE PLANT.

REPRODUCTION.

The chief object for cultivating the soil is for the production of plants. The particular object of each plant is the perpetuation of its kind. The reproduction of plants, therefore, is the nature of plants.

All cultivated plants produce seed at some stage of their development. Though other methods of reproduction may be followed in practice the seed remains the great original means of plant propagation. A knowledge of the principles involved in the transformation of seed into plant is essential to intelligent control of crop development.

Seed formation begins with the flower differing for each kind of plant. So far as the purposes of reproduction are concerned all possess one characteristic in common. **All Flowers possess Sex.**

Sex of Plants—Reproduction is possible only by the influence of both sexes. In plants, however, both sexes may be united in a single plant.

Flowers are the reproductive organs,—the sex evidence,—of plants. They are of three different kinds according to their single or double sex functions.

Bisexual flowers have all reproductive organs present in the same flower. Beans illustrate this class of plant.

Monoecious plants bear flowers of different sexes on the same

plant. Indian corn illustrates this form of development, the tassel being the male and the silk the female organ.

Dieoecious plants produce the two sexes on different individual plants. Asparagus is of this nature.

The female organ of the flower is the stamen, and the male is the pistil. Therefore, **staminate** flowers are female and **pistillate** are male. Flowers possessing both these organs in the same individual are called **perfect** flowers.

Pollen is the male element developed on the pistils of either male or perfect flowers. This is the yellow dust so lavishly produced by corn tassels and other pistillate flowers. The carrying of this fertilizing burden is the special office of bees and explains their importance in the development of so many fruits. This function is particularly essential with all members of the melon family.

Another fact of the utmost importance is dependent on this matter of the sex of flowers.

Some varieties of certain plants have flowers of only one sex. In order to produce fruit, therefore, it is indespensable that another variety of this kind of plant, with flowers of the other sex, should grow in close proximity to the former.

Strawberries are the best illustration of this condition. This fact explains what seems a mystery to many people. They plant a single variety and then wonder why plants which bloom freely never bear fruit.

A few varieties of strawberries have perfect flowers; many more produce either pistillate or staminate flowers alone. It is necessary to know the sex of the variety. Then if its blossoms are of one sex, one row of staminate plants should be set for every three rows of pistillate that the blossoms of the latter may be fertilized and produce fruit.

The seed is the direct product of the flower. Seed formation is the object for which the flower develops. It contains the germ of life, the embryonic plant. It is the direct means of most plant reproduction.

Propagation by Buds—All other forms of plant perpetuation depend on some form of bud instead of seed for the purpose.

A bud is a part of the stem of a plant, which, when severed from the parent plant, grows independently. This new plant may grow either by developing its own root system in the ground, or by uniting with the growing tissue of an already growing plant.

Propagation by **cuttings** illsutrates the former and by **grafting** the

latter method, of development. In all the various forms of bud propagation the bud is the essential part of the plant used.

Various parts of the parent plant may be used. Stems furnish the cuttings from roses, the layers of raspberries, and the runners with strawberries. A part of the leaf may be used from begonias, a "slip" from geraniums, and merely a bud from the orange tree. A bulb makes the new plant in the case of hyacinth or onion set and a tuber with the Irish potato. In the former the original stem continues to grow from its central bud, in the latter the eye is really the bud of an underground stem. In all cases the bud makes new growth and reproduces the plant from which it came.

There are two important reasons for the common use of buds rather than seed for plant reproduction. **First,** many plants do not produce seed in one season. Onions illustrate this kind of plant. A second year's growth from the first year's bulb is necessary for the development of seed.

Second, the seeds of many plants do not "come true," that is, when planted, they do not produce plants like that from which they come. This is particularly true of fruit-bearing trees, and is the cause for the almost universal dependence on grafting for the perpetuation of varieties.

The simple reason for the fact that seeds from so many plants do not reproduce their kind is that seed often result from,—and represent the characteristics of,—two very unlike parents. This fact is demonstrated in the frequent presence of corn of several kinds and colors on a single cob. This condition is equally true of a peach or strawberry seed, though not apparent to the eye.

The bud, on the other hand, is a part of a single plant. It represents only one parent and may be depended on to unfailingly reproduce the characteristics of the parent plant.

GERMINATION.

The growth of a plant begins with the germination of the seed. For this life-function three things are necessary,—heat, water and air.

Temperature—The amount of heat required for germination differs greatly with different kinds of seed. Radishes begin growing at comparatively low temperatures. Cucumbers, on the other hand, require considerable warmth for the same process.

The germination of most common seeds takes place best at tempera-

tures ranging from 55 to 75 degrees. Within these limits temperature affects the length of time required rather than the final result.

Moisture—The first effect of water upon the seed is to cause it to swell. This is because the seed absorbs water exactly like any other dry porous substance .

The result of this absorption of water is that the seed is softened so that the germ easily forces its way out of its close envelope as soon as growth begins.

The next function of this absorbed water is chemical. It starts fermentation, and this process is necessary to prepare the first food for the living plant just beginning to develop.

The germ, heart or living part, of the seed is but a comparatively small part of the whole seed. The chief bulk of the seed, within the hard envelope, consists of starch, as is easily seen in a grain of wheat or kernel of corn. This starch is stored up food awaiting the demand of the new plant. The tiny plantlet, however, cannot feed directly on starch. This must be changed into glucose before it can actually be used by the plant. Fermentation is the means by which this change is effected.

When dry grain or meal is immersed in water bubbles of gas begin to rise in a few hours and the water soon has a sour smell. Fermentation has begun.

This is exactly what takes place in the moistened seed. The result of the fermentation. is that the young plant is provided with food to sustain life till it has developed to the point where its tiny rootlets are able to begin the process of taking food from the soil.

Air—With the beginning of germination the seed has become a living thing. To every living thing air is indispensable. The seeds of a few plants which germinate under water contain considerable air within themselves.

Young plants do not actually breathe air. Its chief office is to supply oxygen for the process of fermentation just described. That it is indispensable to this process is illustrated by the well known fact that fermentable substances do not ferment when air is excluded by hermetically sealing.

This necessity for air explains a fact often noticed. When heavy rains fall and pack clay soil hard before sown seed have germinated the stand is often very small. This is not because of difficulty of young plants to come through the hard soil, but because the impacted soil will not allow air to reach the sprouting seed.

The soil must lie close around the seed, but not so much so as to exclude air. The amount of pressure needed to pack the soil sufficiently for supplying water must vary with the kind of soil, being greatest with porous sand and least with dense clay.

PLANT GROWTH.

When the young plant, starting either from seed or bud, enters upon its independent existence it begins to grow. Plants, like animals, grow by the formation of new cells. These new cells are new plant substance formed by the assimilation of food.

Plant growth, therefore, involves two separate processes,—**feeding and growing.** These are really cause and effect, since the result of feeding is growth.

The process of plant feeding involves organs and parts of the plant the functions of which are best understood through familiarity with the processes of growth. The latter, therefore, will be considered first.

HOW PLANTS GROW.

Stem and Root—When the seed sprouts it sends out two shoots. One of these begins to reach up for air and light. The other immediately goes down in search of moisture and soil food. The former becomes a stem, the latter a root. From these two organs the whole system of the plant is developed.

The stem bears leaves, buds and fruit. It also provides the channel through which sap,— the life fluid of plants,—flows between root and leaf. It is the life current which conveys prepared food to all parts of the plant and supplies the material for new growth.

Leaves—These are the breathing organs of the plant. They are attached to the stem at regular intervals and consist of a framework of veins covered with thin cellular tissue. This tissue is nearly transparent so that sunlight passes through with little obstruction. Leaves are usually green in color and contain chlorophyl which is the active principle in enabling leaves to consume air food.

The upper surface of leaves is more dense and darker colored than the under surface. The latter is filled with infinitely small openings or mouths called stomata. It is through these openings that leaves draw their supply of air.

The pores of the leaf also perform the same function for plants as the pores of the skin perform for animals. It is through the leaves

that water absorbed from the soil through the roots is exhaled into the air. This is a vital process of plants called **transpiration.**

Buds—These form the tip of every live part of the stem. It is from the bud that new growth develops. This new growth may produce such different parts of the plant as stems, branches and flowers.

Root Hairs—The growing roots of plants are covered with delicate fibres so fine as to often look like mould or finest down. They are root hairs which are the feeding organs of plants for securing water and food from the soil. Soil food enters the plant only in form of solution dissolved by water which is drawn into the root by means of these root hairs. Then by osmosis and other forces the solution rises through the stem supplying the cells with food.

Growth is thus provided for.

HOW PLANTS FEED.

Two Kinds of Food—If any part of a dry plant is burned, smoke and gas are given off into the air. Part of the plant is combustible, it goes back into the air because it came from the air; it is **air material.**

If this burning is stopped soon the wood, or other vegetable matter, is only charred; charcoal or carbon is produced. Carbon, therefore, is the chief part of this air material of plants.

If the burning or combustion is allowed to continue the charcoal disappears. The carbon and other air materials all pass back into the air whence they came and ashes alone remain behind. This is the **mineral or soil material** of plants.

It is therefore apparent that plants consist of two distinct kinds of matter,—combustible, or air matter, and non-combustible, or soil matter. Since plants are made of the materials which they consumed as food their food must consist of two classes of material, atmospheric and soil.

It is known that these two groups are made up as follows: I. **Atmospheric:** Water, carbonic acid, ammonia. **II. Soil:** Phosphoric acid, potash, soda, silica, lime, magnesia, iron oxide, sulphuric, nitric and hydrochloric acids.

Certain plants contain a few other substances, but all cultivated plants always contain all of the above named materials. Unless all of these substances are available in the food of crops normal development is impossible.

Mutual dependence of Animals and Plants.—All living things consist of two classes of matter, combustible and non-combustible, organ-

COWPEA PLANT, SHOWING ROOT NODULES BY MEANS OF WHICH THE PLANT TAKES NITROGEN FROM THE AIR.

ic and inorganic. Yet plants feed only on inorganic matter. They possess the power of changing water, carbonic acid and nitric acid into organic matter. They are able to take water and carbonic acid which not only will not burn, but which will extinguish fire, and recombine them into substances which will burn.

Neither of these two classes of matter can alone produce plant growth. The presence of each is indispensable to the use of the other. The atmospheric ingredients of plants make the transformation of soil material into vegetable matter possible. In like manner soil constituents are necessary to the change of atmospheric foods into animal and vegetable forms.

USING ATMOSPHERIC FOOD.

Food enters the plant through two different organs,—the leaf and the root. Carbonic acid and a little oxygen are taken directly from the air through the leaves. All other plant food is taken up by the roots and dissolved in soil water.

Organic Ingredients of Plants—These are of air origin and consist chiefly of starch, sugar, cellulose fat and albuminoids. The latter contain nitrogen. The other substances consist entirely of carbon, hydrogen and oxygen.

The process by which these vegetable compounds are formed is simple. Sunlight is the active agent in their formation.

Air always contains carbonic acid. It is exhaled by all animals and is a product of all decay. Air containing carbonic acid comes into contact with plant leaves and enters them through their stomata.

By the action of sunlight the carbonic acid is decomposed, broken up. Its oxygen is liberated to pass back itno the air which is thus purified by the growth of plants. The carbon remains behind and combines with the elements in the sap of the plant to form the carbohydrates, the starches, sugars, gums and fibre of which the plant so largely consists.

For the formation of the Albuminoid,—or nitrogenous constituents of plants,—which form so large a part of fruits and seeds, a further process is necessary.

The action of nitric acid, taken from the soil, upon the ingredients of the plant sap taken from the air, results in the formation of this class of plant compounds. By these two processes the entire organic mass of vegetation is formed.

USING SOIL FOOD.

Roots are the parts of the plant through which soil food enters the circulation of the plant. Root hairs are organs directly engaged in this food absorption.

Soil food enters the plant only in the form of solution.

Means of Solution—Water is of course the direct medium of solution, but water alone is not responsible for all the dissolving action going on in the soil. Soil waters always contain certain minute quantities of mineral acids formed by chemical action in the soil itself. Ammonia is a product of all decay. Carbonic acid, nitric acid, and ammonia greatly increase the dissolving power of water.

By the presence of these active agents insoluble soil minerals are either directly dissolved or are converted into soluble compounds.

Moreover the root itself secretes an organic acid exerting a great dissolving power on soil minerals and enabling the plant, to a considerable extent, to render its own food available.

Selection of Food—Though roots have no power of rejecting material once in solution in the soil they possess a cerain power of selection by being able to seek out places or localities containing the food of which they stand in immediate need.

Plants are incapable of selecting the food actually required and rejecting that not needed. It is necessary, therefore, to show how different plants, wholly unlike in nature and composition can grow side by side in the same soil yet extract different foods from that soil.

The cell wall possesses osmose action; certain substances in solution pass through the membrane while others do not.

Soil water continues to dissolve each mineral constituent until its point of saturation is reached. This means that when the solution can contain no more of any single food material the dissolving of that particular substance stops. The root takes up the entire saturated solution, which is the same strength inside and outside the cell.

The plant requires some of one or more of these materials. The needed material passes through the cell wall and becomes a part of the tissue of the plant.

The solution inside of the cell thus becomes more dilute than that outside. Then more of this material enters the cell till the solution is again saturated and the strength on both sides is again the same.

If the plant requires no more of this particular food it absorbs no more and the solution being saturated no more can be dissolved. The action does not continue and the use of this particular food ceases.

In this way any plant satisfies its own demands from the same soil water.

Absorptive Power of Soils—Soil waters are constantly dissolving the food materials of soils even when there is no immediate demand by plants. It seems at first strange that all the nutriment in soils is not washed out and wasted by draining away. This calamity is prevented by the power of absorption possessed by all soils. This is not mere mechanical absorption but a distinct manifestation of chemical action.

All soils possess this property in some degree. Even coarse sand, the most porous of soils, is used for purifying water because it filters out and absorbs impurities. This absorptive power is the real secret of soil fertility. Without it plant food once dissolved would pass through and out of the soil if not immediately taken up by plants.

Not all plant materials are absorbed alike. Ammonia, potash, soda, lime and magnesia are readily absorbed. Silica, phosphoric, sulphuric, hydrochloric and nitric acids are absorbed to only a very slight extent.

The all important fact is that most of the essential constituents of plant food are absorbed and retained in the soil in forms available to tne plant. Nitric acid is the one most important exception. As this is the final product of organic decomposition before the plant actually consumes its required nitrogen this fact is of less significance. It explains the necessity, in practice, of applying nitrogenous fertilizers only in quantities to meet the immediate needs of crops.

III—PLANT FOOD.

The material used by plants for making growth is plant food. Fertilizers and manures are simply the materials used for supplying plant food in excess of the supply provided in the soil itself.

NEEDS OF THE PLANT.

As already stated plants need for their normal growth fourteen different substances. Each of these is equally important. The one used in smallest quantity is as indispensable as the one used most largely. Moreover, substitution of one food element for another is not possible.

Most soils, however, contain very much more of certain materials than of others. Plants also require certain food elements in very much greater quantity than others.

The demand for certain plant foods is relatively very much greater than for others,— far in excess of the capacity of most soils to supply. The practical importance of five plant constituents is greater than for all others.

These five are phosphoric acid, nitrogen, potash, lime and magnesia. The demand for the last two in excess of the natural supply is only occasional, with certain plants or certain exceptional conditions of soil. With the other three, however, the demand of cultivated plants is in excess of the natural ability of soils to supply. Soils become rapidly exhausted by these three elements so that continued productivity necessitates constant supply by artificial means.

THREE ESSENTIALS.

For these reasons phosphoric acid, nitrogen and potash are considered the three essential plant foods. They must be regularly returned to soils by artificial means to make good the loss by cropping. They are the valuable ingredients of all manures and fertilizers.

The reason why these three substances are really essential to the continued production of crops should be fixed in mind.

Crops are removed from the soil; they are sold as the market product of the soil. Plant food is the raw material from which crops are made.

If crops remain on the soil which produced them exhaustion of the supply of plant food would be impossible. When corps are sent away, as cotton or fruit or milk, the return of the three food constituents,—in some form or by some means, is essential to continued production.

FORM OF SUPPLY.

Plant food cannot be supplied to crops in the form in which the plant must finally use it. Nitrogen in its pure state is a gas. Phosphoric acid and potassium never exist in pure state in nature, nor remain pure long after artificially produced.

Commercially, therefore, they must be purchased, shipped and applied in some one of the different forms in which they can be procured.

The case is identical with that of animal foods. Animals need protein, but there is no way by which pure protein can be practically supplied. Even could this be provided animals would not find it palatable and would not eat it. We, therefore, provide beef or wheat bran as a source of protein for animals.

Commercial fertilizers and manures occupy the same place with plants that bread, beef, vegetables, hay and grain do with animals.

Nitrogen for plants is supplied in the form of animal and vegetable wastes, and chemicals. Phosphoric acid comes from animal bones and mineral phosphates. Potash is used in the shape of ashes and potash salts.

In each case the form is merely a matter of convenience and economy. The real object and value lies in the supply of one of the three plant food essentials.

SOURCE OF SUPPLY.

Several forms of fertilizers contain more than one plant food essential. This is noticeably so of farm manures which contain all three in varying proportions. Most fertilizing materials of animal or vegetable origin contain two of the essentials, though often the phosphoric acid is not in a form to be immediately available to plants.

Phosphoric Acid is used chiefly as phosphate of lime. The largest supply comes from animal bones and mineral phosphates. The chief deposits of the latter used in America are the petrified remains of prehistoric animals found in South Carolina, Florida and Tennessee.

The phosphate of lime in these sources of supply is insoluble and, therefore, not available to plants. It is converted into soluble, or available, phosphate by being treated with sulphuric acid.

The product is super-phosphate, or acid phosphate, by which name it is known commercially.

Nitrogen exists as one of the constant ingredients of the air. Plants, however, are not able to take this essential directly from this inexhaustible source.

Certain plants of the pea and bean family, known as legumes, have the power of fostering bacterial action in the soil by means of which nitrogen is taken from the air and incorporated with the soil where it becomes available to plants.

Nitrogen is a constituent of all animal and vegetable matter. By decomposition of the latter ammonia is found and this in turn becomes changed into nitric acid, in which form the nitrogen contained is used by plants.

Animal manures, blood, tankage and cottonseed meal supply nitrogen by this process.

Nitrate of soda is a mineral salt found in large deposits, and sul-

phate of ammonia is a product of gas manufacture very largely used for fertilizing purposes.

Potash is the essential most restricted in sources of supply. It is a constituent of all wood ashes, but this source is now of little commercial importance. Nitrate of potash, or saltpeter, is a natural deposit in tropical countries. The natural supply is so limited as to be of little agricultural importance. It is produced artificially in certain industries in a form used for fertilizing purposes.

The great source of agricultural potash is found in the Hartz Mountains in Germany. Several of these salts of potash are used as fertilizers. The sulphate, muriate, kainit and double-manure salt are the best known. Each has its special adaptions.

The muriate is the most economical for general use. The sulphate is particularly adapted to fruit and crops like hops, where aroma and flavor are important qualities. The double-manure salt seems to meet the particular demands of citrus fruits and tobacco, while kainit is a specific for cotton in sections where the crop is subject to the yellow rust.

AVAILABILITY.

It is important to bear in mind that plants consume food only in solution. This fact has particular significance in connection with two of the three essentials. Phosphoric acid and nitrogen both exist in forms practically useless to plants because so extremely and slowly soluble in the soil as to be practically unavailable.

Natural phosphates are all unavailable until treated with acids. Organic nitrogen,—the form existing in leather, horn and peat,—though very abundant, is practically useless as plant food. The most unfortunate condtion in this connection is the fact that the chemist is unable to detect the difference in the forms of nitrogen of animal origin.

Potash in all its commercial forms is immediately available as plant food.

PROPORTIONS AND QUANTITIES.

The basis for determining what and how much fertilizer to use is found in the composition of the crop to be grown.

In practice this must naturally be modified by the conditions of growth of the crop in question. Two such conditions would be the ability of procuring nitrogen from the air by bacterial action and the presence of tap roots capable of securing food from great depths.

The old idea that analysis of the soil could show the food demands of the crop it was to produce is now discarded.

The crop not the soil is the thing to be supplied with plant food,—fertilizer. Even were this not so true, analysis of the soil can only show what is present at the time the analysis was made. Yet air and rain, heat and cold, are all the time at work on soil constituents. Plant food is constantly being dissolved, so that no analysis can posbly show what may be available during the entire growing season.

FERTILIZER CALCULATIONS.

This matter is really very simple though looked upon as a mystery by many people to whom it is of most importance.

Any person who can correctly calculate the number of acres in a field can calculate the formula, analysis, or value of any fertilizer.

It is not necessary to know the properties of the different fertilizing materials. It is not necessary even to know the meaning of terms or words ususally found on fertilizer sacks or tags.

Never mind about "potential ammonia," "citrate soluble," and the other confusing expressions.

The valuable part of any fertilizer consists of three things only: Available phosphoric acid, nitrogen and potash; K2O. is simply a short way of saying potash, just as Mr. is short for Mister. To the chemist the letters "K2O. convey a little additional information, of no practical value to you.

The term per cent. is simply short for parts in a hundred. One per cent. simply means 1 part in 100 parts—1 pound in 100 pounds.

To Make a Given Analysis—The most common query from farmers wishing to mix fertilizer is: "How can I make this analysis?"

We will show how to proceed by taking an actual case. Suppose we would mix an 8—3—3 formula.

This analysis means that 100 pounds of the mixed fertilizer contains 8 pounds of phosphoric acid, 3 pounds of nitrogen, and 3 pounds of potash.

One ton contains twenty hundred pounds. Therefore one ton contains twenty time sas much of each ingredient as 100 pounds contains.

Multiply the per cent. by 20—This gives the number of pounds of each ingredient in one ton. This is the first and indespensable step in calculating a formula. In the above case, 8 multiplied by 20 equals 160; 20 multiplied by 3 equals 60; 20 multiplied by 3 equals 60. One ton of this fertilizer, therefore, contains 160 pounds of phosphoric acid, 60 pounds of nitrogen, and 60 pounds of potash.

To make a fertilizer analyzing 8—3—3 it is simply necessary to use enough of each of the raw materals at hand to supply the above number of pounds.

For phosphoric acid we will use acid phosphate containing 16 per cent. of available phosphoric acid. We need 160 pounds of this available acid. To find the quanitty of raw material needed to supply the per cent of the ingredient desired **divide the number of pounds of the Ingredient in question in one ton of the mixed fertilizer, by the number of pounds of that ingredient in 100 pounds of the material to be used.** The result will be the number of hundreds of pounds of the raw material used to give the percentage desired in the formula.

In the case in hand 160 pounds divided by 16 equals 10. Therefore, 1,000 pounds of acid phosphate gives 8 per cent of available phosphoric acid in one ton of 8—3—3 fertilizer.

For nitrogen we will use cotton-seed meal. This contains 6.18 per cent.—pounds per hundred—of nitrogen. We need 60 pounds of nitrogen to furnish 3 per cent. in the finished fertilizer.

Now follow the rule: 60 pounds divided by 6.18 equals 9.6. Therefore we must use 960 pounds of cotton seed meal to supply the 3 per cent. of nitrogen in the proposed mixture.

We now require 60 pounds of potash to complete our formula. Part of this is supplied by the cotton seed meal which contains 1.8 per cent of potash. The 960 pounds of meal used, therefore, contains 17 pounds of potash, which leaves 43 pounds to be supplied.

We will use muriate of potash for this purpose. This contains 51 per cent. of potash. Following the rule we find that 43 divided by 51 equals 0.84. To supply the full amount of potash, we therefore, need 84 pounds of muriate.

Our complete formula would now contain—

	Pounds
Acid photphate	1,000
Cotton seed meal	960
Muriate of potash	84
Total	2,044

It is now seen that we have mixed a little more than 2,000 pounds. In home practice this is immaterial. The figures given are, however, rather inconvenient for weighing and figuring. It must be remembered that we have taken the guaranteed composition of the raw materials used. These are the minimum or lowest content. In order

to be on the safe side most raw materials, and fertilizer chemicals, acutally run over the guarantee. It is, therefore, perfectly safe, and more convenient, to use even quantities in mixing.

Our practical formula would, therefore, best be made up as follows:

	Pounds
Acid phosphate	970
Cotton seed meal	950
Muriate of potash	80
One ton	2,000

Analysis: 8—3—3.

HOW TO FIND THE ANALYSIS OF A GIVEN MIXTURE.

It is very common for a farmer to have certain materials on hand or available, which he thinks of using in certain proportions. He would however, like to know the composition or analysis of the proposed mixture.

Let us take a common mixture: Acid phosphate, 16 per cent, 1,000 pounds; cotton seed meal, 800 pounds, and kainit, 200 pounds. One thousand pounds of acid phosphate, 16 pounds of phosphoric acid per hundred, contains 160 pounds of available acid. Eight hundred pounds oı meal, 6.18 pounds oı nitrogen per hundred—contains 50 pounds of nitrogen. Two hundred pounds of kainit, 12.5 pounds per hundred, contains 25 pounds of potash. The 800 pounds of meal contains 1.8 pounds per 100, or 14.4 pounds of potash.

We have therefore, in this mixture: phosphoric acid, 160 pounds; nitrogen, 50 pounds; potash, 39.4 pounds.

To find the per cent. of each of these amounts in one ton we divide each by 2,000, with the following result: Phosphoric acid, 8 per cent.; nitrogen, 3 per cent.; potash, 2 per cent—analysis, 8—3—2.

Calculating Value—We mean the commercial or market value, as crop, season and price of crops must determine the agricultural or real value to the user.

The average wholesale price of the materials used is the basis for this calculation. This varies with trade conditions, but the average vaıue of the three essentials may be accepted as about **4 cents per** pound each for phosphoric acid and potash, and 18 cents per pound ıor nitrogen.

The value of the above formula would, therefore, be as follows:

160 pounds phosphoric acid, at 4c	$ 6.40
56 pounds nitrogen at 18c	10.08
39 pounds potash at 4c	1.56
Tax, mixing and bagging	2.60
Value per ton	$20.64

The last item is allowed by most States as a fair charge. To it must be added the cost of transportation from place of manufacture to consumer.

Converting Nitrogen and Ammonia—These terms are used so interchangeably that it is necessary to be able to convert each into the equivalent of the other.

To change per cent. of ammonia into nitrogen, multiply by 0.8235.

To convert per cent. of nitrogen into equivalent in ammonia, multiply by 1.214.

Here is the way: 3 per cent. of ammonia multiplied by 0.8235 equals 2.47 per cent. nitrogen; 2 per cent. nitrogen multiplied by 1.214 equals 2.44 per cent. ammonia.

To change nitrate of soda into an equivalent amount of ammonia, divide the per cent. of nitrate of soda by 5.

To change nitrate of soda into an equivalent amount of nitrogen, divide the per cent. of nitrate of soda by 6.

To change nitrogen into an equivalent amount of nitrate of soda, multiply the nitrogen by 6.

To change sulphate of ammonia into an equivalent amount of ammonia, divide the per cent. of pure sulphate of ammonia by 4.

To change ammonia into an equivalent amount of sulphate of ammonia, multiply the per cent. of ammonia by 3.9.

To change nitrate of potash into an equivalent amount of nitrogen, divide the per cent. of nitrate of potash by 7.2.

The principles and methods of calculation are the same whatever the materials to be used or the formula to be made. **Careful study of these examples will adapt them to all conditions.**

PART III.

SIMPLE BOTANY.

I.

BOTANICAL DIVISIONS: PARTS OF A PLANT.

Botany is the study of all plant life. The field is so large that the subject must be divided into special branches. No one can hope to be master of them all. To-day we have men devoting their entire time to the study of plant physiology; others working on the classification of plants, the diseases of plants and so on, through the numerous phases of the subject.

There are four great divisions in the vegetable kingdom. The name of each division is a Greek word of which the ending, phytes, signifies "plant;" and the beginning, the kind of plant. The first division consists of vegetation of the simplest structure and the last takes in the most complete plants.

(a) **Thallophites**—This group takes in the one-celled plants, as algae and also the fungi. Among the latter we find many of the causes of plant disease.

(b) **Byrophites**—Moss plants. The group consists of mosses, liverworts and allied forms.

(c) **Pteridophites**—Fern plants. The horsetails and other forms are also within this group.

(d) **Spermatophites**—Seed plants. This is the highest and most complex group, consisting of all the forms that produce seed, as apples, peaches, berries, etc. This group may be divided as follows

(1) **Anglospermes**– Seed borne in closed ovary.

(x) **Dicotyledons or Exogens**—Plants having hard woody stems as most trees, leaves netted, veined and the seed always has two cotyledons (halves).

(y) **Monocotyledons or Endogens**—Plants with soft stems and parallel veined leaves as corn; the seed has only one cotyledon.

(2) **Gymnosperms**—Seed borne naked on an aborted leaf or scale, as in the pine family.

PARTS OF A PLANT.
1, Root; 2, Stem; 3, Leaf; 4, Flower.

The dicotyledenous group is the most important one in the study of fruits. In floriculture, however, the monocotyledons assume great importance.

The Parts of a Plant—A single plant may be divided into the following parts Root, stem, bud, leaf, flower, fruit and seed. Each of the these parts furnishes the subject for separate consideration. We will then take up reproduction, horticultural methods of propagation and special fruits.

THE VEGETABLE KINGDOM.

The world about us is commonly divided into three kingdoms—(a) the animal, (b) vegetable, and (c) mineral. The component parts of the animal kinguom have ilfe, and all at some time the power of free movement. Among the vegetable we have the power of growth and life, but not free movement. The minerals are inanimate, being placed in position by Nature, and forced to remain there until disintegrated or otherwise changed by some higher power. It would have been better, no doubt, to have named the mineral kingdom the inanimate kingdom, as there are many inanimate substances that are not mineral, among which may be mentioned gases and water. Growth in animals and vegetables is entirely different as the ends to be attained differ so widely; so also do the food substances and likewise the resulting products of growth. Many of the same chemical elements found in animals exist also in plants, but in a different form. A good example of this is the element carbon, chemical symbol being C. Animals get their C. mostly from vegetable substances, as sugar and starches. They give off from the lungs, as a product of the life process a gas composed of two parts oxygen and one part C, called carbon dioxide, chemical symbol CO-2. This gas is taken up by all green-producing plants and the C of it used, being made again into sugars and starches for the animals.

The above paragraph serves to show, in a general way, the close relation existing between the animal, vegetable and inanimate kingdoms. The bodies of animals and plants are in the main made up of the third class of material; while the products of life processes of animals furnish food for plants, and vice-versa. We will now leave the first and third divisions taking up for special consideration the second.

II. THE ROOT.

Function—The root functions are to hold the plant in place and to

gather food. Not all roots, however, serve to hold plants firm for some have aerial roots that dangle about in the air and are attached to nothing; neither is all of the food of a plant obtained through the roots for some of it is taken in by the leaves. The root system—that is, the entire mass of roots—is generally supposed to take up as much space under the ground and to extend as far as the tree does above. This is not always the case though, for the roots of some trees extend a great deal farther on one side than on the other, for they travel the path of least resistance and often go around under and over rocks to continue their growth. The roots come into close contact with the soil and in that way anchor the plant. Every one knows that it is next to impossible to pull a plant from the ground and not break some of its roots.

Kinds of Roots—There are numerous kinds of roots, among which may be menioned underground roots, water roots, air roots, clinging roots and prop roots. Underground roots may be divided in two main classes:

(a) **Tap-rooted Systems.** These have a main, leading root that goes straight down into the ground; cotton is an example.

(b) **Fibrous-rooted Systems.** These have the tip, while the stem grows in length for some distance behind the terminal portion.

Root Hairs—Just back of the tip of a growing root are numerous little hairs. They are very small and often cannot be seen without a magnifying glass. It is through these that the major part of the plant food is taken in. They are very delicate and do not live long. As the root increases in length the old hairs die and new ones are formed nearer the tip. The old roots do not absorb but simply carry material. The small hairs near the growing tip do most to maintain the life of the plant. These little tube-like sructures weave themselves around the grains of soil and cling tenaciously to them; in this way they get in closer contact with a greater soil area and obtain more food and moisture. A seedling grown in sand when pulled out will bring a number of grains tightly held by the tender roots, showing how close the contact is with the soil.

How Roots Feed—All the water and most of the food elements are taken in by the roots. The food materials must be in solution as the roots cannot take them up in a pure form. Carbon and oxygen are obtained mainly through the leaves; the other elements, as potassium, phosphorus, nitrogen, calcium, magnesium, sulphur, iron, chlorine and hydrogen, are taken through the roots.

The process by which the food solution is taken into the plant is called **Osmosis.** To understand osmosis we must first know that two salt solutions when mixed together diffuse one into the other until both are of the same specific gravity; that is, the whole mass eventually becomes of the same weight throughout. Now, the separating of the original solutions by a permeable membrane does not prevent the diffusion; and the weaker liquid always passes into the stronger at a more rapid rate than the stronger does into the weaker. Take a sugar solution and separate it by a hog bladder from pure water. The water will pass through the bladder into the sugar faster than the solution will pass into the water. That is the sugar solution will be increased in volume while the water decreases; therefore, the space originally occupied by the sugar solution will become too small and pressure will result; this pressure if a tube is attached to the sugar in such a way as to show it, will cause a rise of liquid in the tube. **Osmosis** is therefore the diffusion of liquids through a permeable membrance.

The roots and root-hairs are filled with cell-sap which is generally a stronger solution than the surrounding soil solution, therefore, the soil solution, which contains the food elements, diffuses through the outer cells into the root; gets into the vascular axis and is then conducted to the stem. If the soil solution is stronger than the cell-sap the greater diffusion is from the plant instead of into it, and it loses its sap, thereby dying. This can be easily shown by putting a plant into a solution of nitrate of soda that is too strong, and the stronger the solution the quicker the death. It is evident, then, that the soil solution must be extremely dilute in order not to overpower the cell-sap and extract it from the roots.

After the food is in the plant it is then conveyed, by root pressure, osmotic pressure and other methods that are not well understood, into the stem or trunk.

III. THE STEM.

The Stem or Trunk is that part of a plant that bears the leaves branches and flowers. It is the stem that generally gives character to a plant: we can recognize a pine at a distance by the looks of its trunk and general shape; a Lombardy poplar is easily told by its peculiar habit of growth, and so on through numberless varieties of plants

Kinds of Stems—We have numerous kinds of stems. There are rigid aerial stems that stand erect and bear great weight of branches

KINDS OF STEMS.

1, Twining; 2, Upright; 3, Creeping; 4, Underground.

and leaves, as in trees; then we have the twining type as in many of the vines such as the morning-glory, these stems are not able to support themselves but must twist about some object in order to get their leaves to the light. There is also a recumbent type that grows up and then bends over, and the creeping stem as in the strawberry, its runners being stems. And as we have roots that live in the air, so also do we have stems that live underground and send up shoots into the air; these root-stocks or underground stems are found quite often among the grasses, our common Bermuda having that. Some underground stems are used as food store-houses; such an one is the Irish potato.

Stems always bear leaves or some modification of them; the underground stocks have little scales that are true leaves though not green. Buds are also borne on the stem; by these characters stems are easily distinguished from roots. Sometimes stems are so short and abortive that it is difficult to make a strict separation; but usually the region where the root stops and the stem begins is quite plainly marked and is called the **crown** of the plant.

Office of Stem—We might say that the main office of the stem is to bear leaves and hold them to the sunlight. Everyone has seen plants in a window and noticed how the stems were often bent towards the light. This is caused by an effort to obtain as much sunshine as possible. Underground stems are of course, controlled by gravity, they, however, often send up leaves into the air and light. Another function of the stem is to conduct unelaborated, or simple food, from the roots to the leaves and then to distribute the complex, or elaborated food materials from the leaves to other parts of the plant.

Structure of Stems—We will confine ourselvse to the **endogens** and **exogens** with just a word about the **gymnosperms**.

Endogens—Monocotyledons, as corn and palms. In this class the vascular bundles (these are the bundles of tissue through which food is conducted) are scattered irregularly throughout the fundamental tissue of the stem. They are not parrallel or arranged in circles about a common center and are closed. On the outside of these stems there is a hard rind or epidermis; they do not have the corky bark as in the exogens. The trees belonging to this class are found only in the tropics, with us there are examples in the Indian corn grasses and other small plants. Endogenous stems do not increase in diameter from year to year and are usually a straight shaft.

Exogens—Dicotyledons, as maples, oaks and numerous other plants.

In these the vascular bundles are about a commo ncenter which is generally filled with pith. On the outside of the bundle is found the **cortex** of fundamental tissue and then on the outside of the cortex comes the epidermis; this latter disappears as the tree grows and the cortex becomes a corky layer which is principally part of a bark, being very thick in some trees as in the cork oak. Just under the bark is found the **camblum** or growing layer of the stem; and it is here that new growth is put on from year to year . The gymnosperms, trees like the pine, are much the same as the exogens except that they have numerous resin ducts which are not found in the latter; the method of growth, arrangement of bundles etc., is practically the same.

Other Stems—It must not be thought that the above mentioned stems are the only kinds, as we have the fern type and numerous others, which, however, we lack space to describe.

Action and Method of Growth of Stem—The following refers to the exogens and gymnosperms. The crude food material, or sap comes from the roots and upon entering the vascular system of the stem is carried up to the leaves. It makes its ascent in the sapwood that is the growth of the last few years; as the tree grows older the heart-wood conducts less and less material until finally there is no food carried through that part of the tree at all. After the leaves have elaborated the sap into food available for use it is then distributed by the layer of the stem under the bark. This is the growing layer, the cambium: it is the increasing in thickness of this layer, stopped by some climatic condition that causes the rings in the trunk of a tree, commonly called the **annual rings.** The age of a tree may be estimated by these, though sometimes there is more than one formed in one year.

The cambium makes two kinds of growth. It forms the bark on the outside and another on the inside. The inner part made this year becomes sap-wood next; the bark formed this year is pushed out by that formed following and must crack and split, being made into corky patches by the pushing out of the new bark thus allowing the tree to increase in diameter. As the cork becomes old it falls away leaving new bark to protect the cambium. This cambium is very important in grafting, as will be shown later; it is the cutting of this layer in ringing or girdling that causes death, for though in a girdled tree the sap can go from the roots to the leaves the elaborated food cannot get back to the roots, and therefore they starve to death and the tree dies the year after is has been girdled. In the cells of this layer may be found **chlorophyll** which gives the greenish color

to the new bark. This substance will be treated more fully under the subject of leaves; the cambium will be referred to again in Horticultural Methods of propagation.

Stems grow in length for some distance behind the tip. In this they differ from roots, which elongate only at the tip.

IV. THE BUD.

A bud is a covered resting, growing point; that is, a winter bud in climates where the seasons are well marked is always covered; however, in tropical countries, where there is no fear of cold or drought, the buds may be naked. Through unfavorable climatic conditions, plants ,especially trees, are often forced into a period of inactivity, and for the same reason that food is stored in tubers and other plant parts; so also are embryo branches and flowers formed by the plant.

A Winter Bud is a shortened branch surrounded by leaves or flowers, sometimes both ,and the whole protected by a covering. This covering is formed of leaf scales closely wrapped about one another. The outer scales are really leaves, comparable to the leaves of the underground root-stocks mentioned in Chapter III. Sometimes under the leaf scales are found rudiments of true leaves and in fruit buds may be found the embryo flower.

When spring comes the shortened branches begin to elongate, the outer scales fall away and if embryo true leaves are in the bud they expand. If a fruit bud the flower comes out and opens up ready for fertilization and the setting of fruit.

Buds are always found in the axils of leaves; that is, in the angle made by a leaf stem with the branch of a tree. When frost comes the leaves fall away leaving a scar which can be easily seen, while the bud remains. Sometimes there is more than one bud above the leaf, as many as three are quite common. Buds are found on the sides of branches and in many plants at the end of the twig. A bud on the end of a branch is called a **terminal bud,** and its purpose is to continue the growth of the stem in a straight line the next season. The side buds are known as **lateral buds.**

There is a struggle for existence between the buds on the limbs just the same as there is a struggle for existence in every kind of life. Some buds are weak or not in a good position to obtain heat and light and therefore do not grow. They may live for several years, however, producing no growth. These are known as **dormant buds,** and if at any time during their existence it becomes necessary for the

1. TERMINAL BUD. 2. LATERAL BUD.

welfare of the tree they spring into perceptible life. This type of bud is usually found near the base of the limb.

Sometimes buds appear on unusual parts of the plant as along the branches not above a leaf or on the roots. These buds are never in any definite order and are known as **adventitious buds.** They are formed at unusual times as when a limb is cut or injured or even when the whole top of a tree is killed. Then sprouts are put forth, known as water sprouts. This growth comes from buds made for the occasion; they did not already exist.

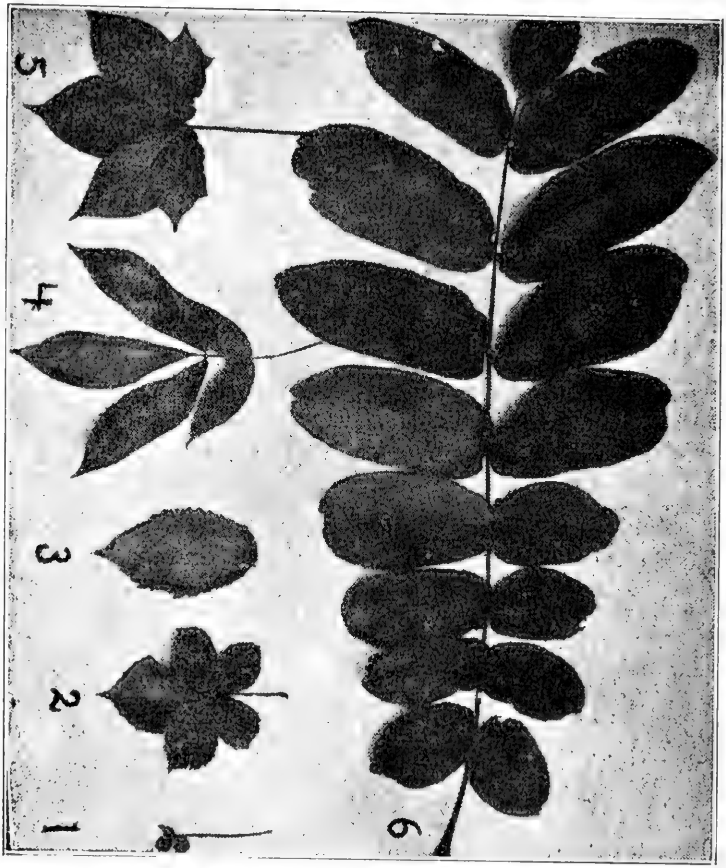
As mentioned above, buds may produce only branches and leaves or simply flowers; still, on the other hand, they may produce all three —leaves, branches and flowers: then they are called mixed buds. Examples of the latter kind may be found upon the pear and apple. These two plants bear their fruit on much sortened branches known as fruit spurs; the peach, on the other hand, bears its fruit laterally on the wood of last season's growth. The knowledge of these facts helps greatly in pruning. Examples of separate fruit and leaf buds occur on the apricot, almond, peach and many other early flowering fruits.

Within the fruit buds of a plant, we might say, is contained the crop of the coming season. The scales act as a protection from the cold of winter; they are assisted in this by a mucilaginous substance given off by the plant. This helps to hold the scales close together and keep down the loss of moisture. The protoplasm or living substance of the tree being dormant can withstand quite a bit of cold. Sometimes, however, the temperature goes too low for even the dormant protoplasm and the buds are injured, oftentimes being killed. If this happens the crop for the coming year is blasted. Possibly the whole tree is not killed; if so, then adventitious and dormant buds come into play and through their growth sustain the roots.

The buds that put out in the spring are formed the previous growing season by the tree. This is why oftentimes trees skip a year in bearing a crop. Heavy fruiting trees take so much of the plant's vitality that it cannot form suffiicient fruit buds for the coming year; therefore puts its energy into the forming of leaf buds to sustain its life. On the off year the food that would have gone to fruit is used in the making of flower buds.

V. LEAVES.

A leaf is that part of a plant that is borne just below a bud. In the angle made by a leaf stem with the limb or twig a bud is always found; take, for example, the leaf of a honey locust, the small little green



KIND OF LEAVES.

1. Compound leaf of clover.
2. Palmately compound leaf of a bramble.
3. Simple, primately, netted veined leaf of Elm.
4. Compound leaf of hickory.
6. Primately compound leaf of Japanese walnut.
5. Palmately veined leaf of cotton.

blade commonly called a leaf is not one, for where its stem joins the stalk there is no bud; now follow that stalk till it joins the next, you do not find a bud, therefore that is not a leaf; follow the next stem and where it joins the limb there is a bud, so all above that point is the leaf, a compound one, to be sure, and the little green blades are leaflets. A leaf is composed of three parts, **stipules, petiole** or stem, and **blade.** The stipules are at the base of the petiole where it joins the branch, sometimes they are large and easily seen, at others they are small and fall away early, leaving a scar that is so small that it can hardly be seen. The petiole is the leaf stem, the part that holds the blade. The blade is that portion above the petiole, usually flattened and the most showy part of the leaf.

Leaves have various shapes; some are **cordate** or heart shaped, others **oval, round, lancelate** or long and narrow like a lance, etc. The blades may have their margins, or outer edges entire, that is even, or toothed and lobed in many ways. Sometimes the lobes are so deep that the blade is broken up into numerous little bladelets known as leaflets. All degrees from entire margins to separate leaflets can be easily seen in the woods. When the lobing is so great that separate leaflets are formed we have a compound leaf. This leaf may be composed of some two or three leaflets, as in the clover, or it may be twice compound; that is, the leaflets may again break up into more and smaller ones, as in the honey locust which has a **twice pinnately compound leaf.**

On all leaves one easily sees the little veins or ridges running through the blade. Sometimes the veins are parallel and have no small cross-veins connecting them; these leaves usually have entire margins and are common to endogenous plants like corn. At other times there is one main vein that sends off branches on the sides, and these branches run out to the margins, making the latter irregular: between these lateral branches are numerous little connecting veins, giving the leaf the appearance of a piece of net-work; leaves of this type are known as **netted pinnately veined,** an example is the Elm. Then again, instead of one main nerve, there may be several starting at the point where the petiole joins the blade and running to different lobes, these veins also give off laterals which are connected by cross-veins. A leaf of this type is **palmately netted veined.** Palmate means hand-like; a maple leaf is a good example of this type. Netted veined leaves are common to exogenous plants in the same way that parallel veined ones are to endogens. The veining of the leaves often helps to distin-

guish between the two kinds of plants, though occasionally it does not hold true.

Leaves are influenced by light, more than any other part of the plant, and it is necessary for the life of the plant that the leaves receive plenty of sunshine. Whenever it is impossible for a leaf to get the light it dies and falls off; for instance, looking up into a tree from directly underneath one sees naked limbs with a canopy of waving leaves; on the other hand, if one looks down a tree from above he sees nothing but leaves. Plants have many methods of keeping their leaves from being shaded. The largest laves are near the bottom and the higher up one goes, as a general rule, the smaller the leaf. Especially is this true with herbaceous plants and shrubs. Another way of obtaining light is for the plant to form a rosette, having the petioles shorter on the top leaves and the whole bunch close to the ground. The lengthening of the petiole on the lower leaves is quite a common method of preventing shading. All shading cannot be prevented and sometimes the light is too strong so some plants have means of regulating the surface exposed; a common one is the prickly lettuce, which has its leaves on edge so that in the middle of the day the sun will not strike them directly. Other plants have the power of folding their leaves to protect them from light and transpiration; this latter subject will be spoken of later.

Functions of Leaves.—These are numerous; we, however, will consider only three. One of the principal actions of the leaf is **photosynthesis,** meaning literally, **putting together by light.** This function may in part be described as **the taking in of carbon dioxide, CO2, retaining the carbon and giving off the oxygen in the presence of sunlight.** Photosynthesis does not go on in the dark, though it has been noticed to take place under an electric arc light. Leaves tak ein the CO2 given off by animals and by the energy of the sunlight break it up, using the C in building up food and returning the O free to the air. The energy necessary for this work is obtained from the sun. The green color of the leaves is caused by **chlorophyll;** this substance absorbs the sunlight and turns the energy thus obtained to use for the life processes of the plant. Plants that have no green color and parts of plants that lack chlorophyll do not perform photosynthesis. Substances from the roots and the carbon from leaves are made into starches, sugars, etc.; these are the elaborated food that are distributed throughout the plant and stored in tubers, etc.

A second leaf function is **transpiration.** This is the giving off of water into the air. The roots take food in solution and therefore ab-

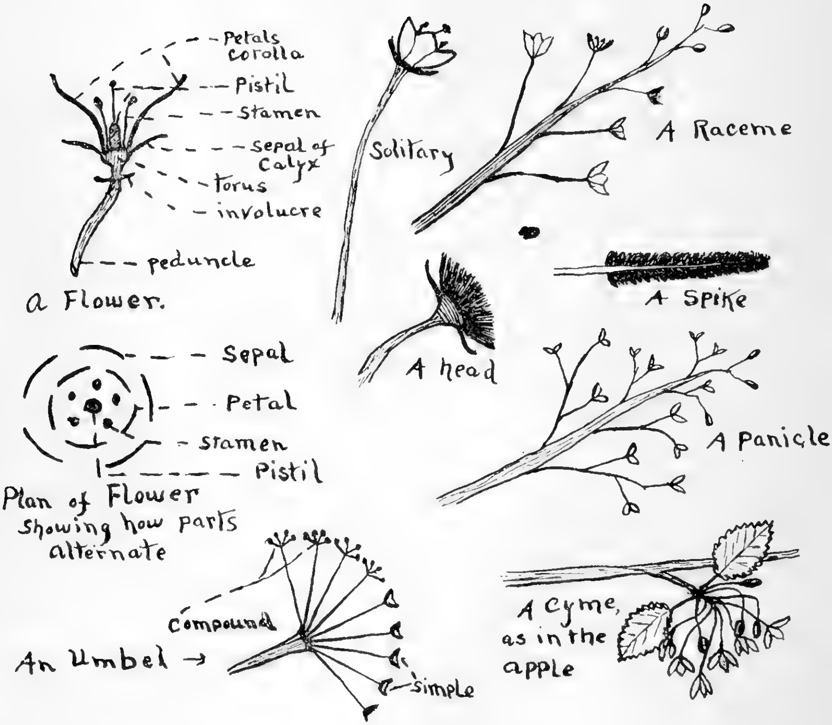
sorb more water than is absolutely necessary for the plant; a great part of this water is given back to the air by the leaves. Transpiration increases in wind and hot weather. There is always a certain amount of water being given off through the **stomata,** openings in the leaves, to see which a compound microscope is necessary; and sometimes, as during a drought, the roots cannot take in enough water to keep life in the plant and supply transpiration, so the leaves wilt. If this condition continues for too long and becomes worse and worse the tree finally dies. Transpiration goes on at night as in the day, so some plants have the power of folding or drooping their leaves, decreasing the surface exposed to the action of the air, and in that way lessening the loss of water: this position is often called the sleeping position of plants.

The last function of leaves that we will take up is respiration. This is the reverse of photosynthesis, that is, the taking in of oxygen and the giving off of carbon dioxide, CO2. For a long time it was not known that plants carried on respiration as animals do, yet they do, though not to as great an extent. The leaves are not the especial organs of respiration as the lungs of man; other parts of the plant, not always green, also have respiration. Though this is one of the leaf functions, photosynthesis and transpiration are looked upon as the main ones.

VI. THE FLOWER.

Every one is more or less familiar with flowers; their beauty attracts the eye, and in many cases their odor pleases the sense of smell. Yet most of us have a very indefinite idea of how they are formed, and why the plant produces them. They are one of the most important subjects in botany, as a great deal of classification is based upon the make-up of the flower. Plants producing the same kind of flowers are placed in the same family, though one may be a tree and the other a shrub not over two feet high. It will be out of the question for us to take up or even mention all the different kinds of flowers in this small space. If any are sufficiently interested to wish to study further a couple of good books to get would be L. H. Bailey's Botany and Plant Relations, by Coulter.

Parts of the Flower—A stem bearing a single flower at the top is called a **peduncle;** also the main stem of a cluster of flowers has the same name; the stem of each separate flower in a cluster is known as a **pedicle.** Sometimes plants, such as the dandelion, send up a straight



KINDS OF FLOWERS.

stem from the crown and on top of this is found one or more flowers; such a stem never has any leaves though it may have bracts, and is called a **scape.**

All parts of a flower, except the enlarged head of the stem, are really modified leaves. Just before reaching the real flower there is sometimes a whorl of little green leaves. This is known as the **involucre** and is more often absent than present. The next part seen is the **calyx.** It may be a green cup, variously toothed and lobed, or composed of numerous separate parts known as **sepals.** Inside of the calyx the **corolla** is found; this is usually the showy part of the flower. It may be of one piece and variously lobed or made up of distinct parts; when separate the parts are known as **petals.** Within the corolla are the **stamens.** They are little organs composed usually of two parts, the **filaments,** or the part which supports the head, the latter being known as the **anther.** This last is often seen covered with a yellow powder called pollen. Within the whorl is found the **pistil;** this may be simple or compound, and is usually composed of three parts. The bottom is the **ovary.** It is here that the seed is produced. Coming from the ovary is a protuberance, sometimes short, at others long, known as the **style,** and on the end of this is generally a little enlargement called the stigma.

Stamens and pistils are the **reproductive organs** of flowers. A flower to be perfect must have both; if it has only the pistils it is a female, or **pistilate** flower; on the other hand, if it has only the stamens it is a male or **staminate.** Some plants bear perfect flowers; others bear male and female flowers on the same plant, and in some species the male flower is borne on one plant and the female on another; therefore, it is seen that there is sex in plants the same as there is in animals.

Any part of a flower may be lacking. Usually when either the calyx or corolla is gone we say that the corolla is missing and call the flower **apetalous** (without petals). A part still unmentioned is the torus. This is the enlarged head of the peduncle upon which the floral parts are borne. Sometimes, however, parts are attached to one another. We often find the corolla or stamens born on the calyx tube. The torus is sometimes called the receptacle, but the former name is the more proper of the two and should be used.

The parts of flowers usually alternate with one another; that is, the calyx is placed in a certain way upon the torus and instead of the petals being opposite the sepals they are placed between them. When the sepals or petals exceed three or five in number they are usually in two whorls, and then they alternate with one another; that is, sepals

alternate with sepals and petals with petals. It is hard, sometimes, to distinguish the different parts of a flower as they grade into one another to such an extent. Flowers double by having their stamens change into petals. In some all stages of this evolution can be seen from true stamens to true petals. Flowers that have their calyx and corolla just alike are said to have a **perianth.** Lilies are a good example of this.

Inflorescence—In botany inflorescence does not mean the kind of flower but the manner in which the flowers are borne. When there is a single flower on the peduncle the inflorescence is said to be **solitary.** Besides the above mentioned form there are two general methods of flower arrangement. The first, **cormybose clusters,** and second, **cymose clusters.** In a cormybose cluster the lower flowers open first and the inflorescence is said to be **indeterminate.** In the cymose clusters it is just the opposite, the older flowers are at the top of the cluster and the inflorescence is said to be **determinate.**

In the corymbose form we find the following types: 1st **racemes,** an unbranched open cluster in which the flowers are born on short stems and open from below up. Wistaria is a good example. 2nd, the **spike,** in which the flowers are sessile on the elongated peduncle and close together. Example Timothy. 3rd. **Head,** being a very short and dense spike. This type of inflorescence is found in the sunflowers. 4th, **panicle,** a compound raceme. Because of the lower branches being older and longer the panicle is usually conical. Example, orchard grass. 5th, **Umbel,** formed when branches of the flower cluster arise from a common point like the frame of an umbrella. A good example is the parsley. Sometimes umbels are compound and the little umbels are called umbellets.

Amongst the cymose cluster there are not as many types. A dense cymose cluster like that found in the apple, pear and cherry is known as a **cyme.** A head -like cymose cluster is called a **glomerule.** Sometimes a flower cluster may follow in part the cymose type and in part the corymbose cluster; such an inflorescence is said to be mixed.

This series of articles was not intended to go fully into all details of botany, so none must feel that we understand all about flowers and inflorescence, but must content ourselves with what little we have learned and pass on to the next subject.

VII. REPRODUCTION.

We have now come to the study of a most important and interesting

period in the life of plants, **reproduction**; it is for this that the plant lives and grows; after it has made provision for the propagation of the species the main work of the season is over. **Annuals**, plants living one year ,after producing their seed die, they cease to exist, having produced in embryo numerous children. **Perennials**, plants that live for many years, as soon as their seeds are produced, give their energy to prepare for next season. Plants have but one object in living and that is propagation; all of their time and all of their energies are spent to obtain but that one thing; they have no other object in life. Reproduction is carried on in the main by two methods: (a) **sexually** or by seed, and (b) **vegetavely**, or by the use of parts of the parent plant.

Sexual Reproduction—Many people do not know plants like animals have sex; that whenever a seed is formed it is done through the fusion of a male and female element. Let us see how this fusion is brought about and by what agencies. When looking at a flower a yellow powder is often seen on the anthers, the head of the stamens mentioned already. This powder is composed of myriads of little yellowish, usually roundish bodies, which are known as **pollen grains**. These are the male elements.

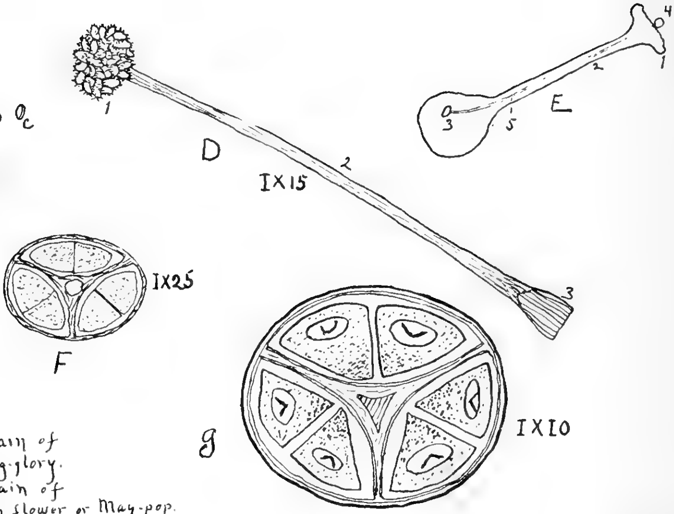
Now call to mind the pistil; remember it is composed of three parts, the stigma, the style and the ovary. The stigma is the receptive surface upon which the pollen grain must find its way; this organ ,when ready for the pollen is covered with a sort of sticky substance. The grain of pollen gets upon it and in a short time germinates; that is, sends out a tube which grows down through the style to the ovary. within the ovary are found **ovules**, or female elements; with these the tube from the pollen comes in contact and a fusion of the two takes place; only one pollen grain acts on each ovule. This is the beginning of the seed; it now grows and matures until it is so well formed that in the future it will be able to reproduce the parent plant.

This fusion of the pollen and ovule is called **fertilization**, and without this process a species that produces sexually would cease to exist unless it also had vegetative methods of propagation; therefore, plants have many methods to facilitate and make fertilization easy. Large numbers of pollen grains are produced and plants that depend upon the wind to distribute their pollen produce much more than other species. Sometimes one hears that a given place has had a rain of sulphur or a yellow snow; this is nothing more than pollen produced by some pine forest and blown many miles by the wind before it is allowed to settle and cover the whole landscape with golden yellow dust.

A

IX80 O_c

B



A.-- Pollen grain of
Morning-glory.

B -- Pollen grain of
Passion flower or May-pop.

C - Pollen grain of
Horse Nettle.

D - Pistil of Morning-glory
1 - Stigma
2 - Style
3 - Ovary

E - Diagram, showing fertilization
1 - Stigma
2 - Style
3 - Ovule
4 - Pollen grain
5 - Pollen tube.

F - Unfertilized ovary of
Morning-glory

g - Fertilized ovary of same plant,
showing how the tissue & structures change

Grasses also depend largely upon the wind for carrying their pollen; the greater number of plants, however, have other means of obtaining fertilization, about the most prominent being insects. Flowers are often showy, filled with honey and have sweet odors; these things attract insects and they come to sip the nectar and in so doing brush the pollen off of the anthers and get it scattered over their bodies and in moving around are pretty sure to get some of it on the stigma, if not in the flower from which they got the pollen, at least in some otner that they visit.

When the pollen of one flower gets on the stigma of another we have what is known as **cross fertilization**; if the pollen gets on the stigma of the same flower it is said to be **self- or close-fertilized.** Some plants are normally cross fertilized, others self-fertilized. Some species to prevent close fertilization have their anthers and stigmas ripen at different times ,so there is no chance of pollen getting on the stigma of the same flower. It is impossible to tell of all the different methods used by plants to obtain the kind of fertilization desired. Such a discussion would fill a book of itself. Suffice it to say that cross-fertilized seed are considered more vigorous and healthy than self-fertilized ones; and also that the probability of pollen from one tree finding its way onto the pistil of another is one of the reasons why seed do not often come true. That is the pollen from a tree producing little yellow peaches may fertilize the stigma of a flower on a tree which bears large red fruit; the seed is a cross between a little yellow and a large red peacn, the resulting seedling takes after both varieties and so there is no telling what it will produce.

Vegetative Reproduction—This is simply the use of some part of the plant to reproduce itself. Sprouts directly from the roots or underground stems are methods. The strawberry produces by its runners as well as from seed. Cuttings are another way. Willows growing along the banks of a stream drop their young branches; these are carried along by the water and getting lodged somewhere on the bank take root and produce a tree; there are many vegetative methods of reproduction in use among plants. They will however, be treated more fully under Horticultural Methods of Propagation.

Other Methods—Among the fungi and lower plants we have reproduction by **spores,** single cells which germinate and reproduce the plant; another method is budding and still another fission. Budding is where the parent cell sends out little buds which themselves become plants; yeast cells reproduce this way. Many bacteria, micro-organisms of an odd shape, so small that they cannot be seen without the use of a powerful microscope, reproduce by fission; that is the cutting in two

of the parent cell, forming two indivduals. Many of these bacteria also produce a spore form. The reproduction of the lower forms, though simple in some respects, is even more varied than among the higher plants.

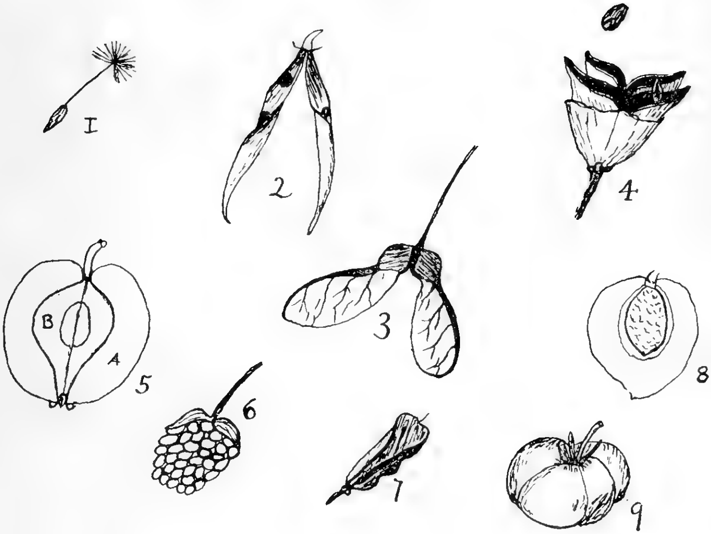
We will next take up a study of the fruit and seed, the two periods of a plant's life which are of especial importance and interest to the horticulturist and farmer.

VII. FRUITS IN GENERAL.

Definitions—A ripened ovary with its various attachments is a fruit. A one-celled ovary containing seed is the simplest kind of a fruit; and from this type we have all gradations up to the very complex structures. The cells or compartments in the ovary are known as **locules**, and as stated above, the least complex kind of a fruit is a one-loculed ovary containing one seed; the next in complexity is a two or many-celled ovary ripened up. Other parts of the flower often adhere to the ovary or change in some way as the fruit matures thus, increasing the complexity of the structures. The style of the pistil may remain, forming a barb or beak; the calyx often persists or the whole fruit may be imbedded in the recepticle or torus, or again the torus may be fleshy and have little separate and distinct fruits on its surface; the involucre may also become a part of the fruit as the husk of the hickory nut or the cup of the acorn.

A ripened ovary is known technically as a **pericarp**, and when other parts adhere to the pericarp it is known as an **accessory** or **reinforced fruit.** Some fruits at maturity split open, liberating the seed. This type is known as a **dehiscent fruit.** Those that do not split or crack open are called **indehiscent.** In the latter type the seed are liberated by the decay of the enveloping structure.

Kinds of Dehiscent Fruits—A dehiscent pericarp is called a **pod,** and the parts into which a pod breaks are **valves.** The simplest form of a dehiscent fruit is a **follicle;** that is a one-loculed pericarp, which dehisces along the front edge, the edge toward the center of the flower. The next form of dehiscence is the **legume.** This type opens along both sutures into two distinct valves; legumes are found in peas, beans and clovers, in fact, the name of our great nitrogen-gathering family of plants is **leguminosae.** A compound fruit consisting of several dehiscing pods bound together is called a **capsule.** There are several methods by which capsules open to let out the seed; when they split along the cepta between the pores it is known as **septicidal dehiscence,** when opening in this manner the locules composing the fruit remain entire and then themselves dehisce as if they were follicles. If the compart-



I - Akene of Dandelion
2 - A legume.
3 - Samara of a maple
4 - Capsule of witch hazel (After Beal)
5 - A pome. A - Calyx, fleshy B - Pericarp
6 - Aggregate fruit of Blackberry
7 - Follicle of Larkspur (After Bailey)
8 - A stone fruit, or drupe
9 - A tomato, true berry

KINDS OF FRUITS.

ments forming the capsule split in the middle and not along the septa it is known as **locilidical dehiscence.** The opening may take place at different parts of the capsule, that is near the top, when it is known as **apical dehiscence,** or near the bottom when it is called **basal.**

Indeshiscent Fruits—A dry, one-seeded, indehiscent pericarp is the simplest form of this type and is called an **akene,** example, the dandelion. Winged indehiscent fruits as in the maples and ash are known as **samarus,** or **key-fruits.**

We next come to the fleshy fruits in which the seed is liberated by the decay of the envelops. Botanically a **berry is a fleshy pericarp with seeds imbedded in it:** the horticulturist, however, calls any small edible fruit a berry: the tomato is an example of a true berry. A fleshy fruit containing one rather large hard stone or pit is a drupe or stone fruit. Examples are the peach, plum, etc. A blackberry is a collection of small **drupelets. Aggregate fruits** are formed by the union of several pistils, the carpels being more or less fleshy; raspberries and blackberries are examples of this class of fruits. The pomes, drupes, berries, etc., will be taken up more in detail later.

Uses of fruits—The main end to be attained by a fruit is to assist in disseminating seed. The dehiscent ones often open with such force that the seed are shot to considerable distance; the fruit of the violet and witch hazel are good examples of this. Some fruits are barbed or covered with hairs which make them adhere to passing objects such as men and animals, thus they are spread. The winged fruits are blown about by the wind; and still others are made in such a way that they are capable of withstanding moisture for a considerab'e length of time without the seed germinating, thus they can be floated long distances by water. The small fleshy berries and drupes are eaten by birds and the seeds being hard, are not injured by the digestive juices and are voided, drop to the ground and sprout. The pomes and large drupes are juicy and pleasant to eat, being quite liable to be plucked from the tree by any animal that can get them. Though we like to think that fruits are especially for man, yet after all they serve a purpose to the tree, otherwise they would not be borne. They are intended to be eaten; they grow to be plucked, they attract attention by their color, and are usually easily seen as they occupy a prominent position on the tree simply because they contain the seed and upon the scattering of this seed depends the welfare of the species.

VIII. REPRODUCTION BY SEED.

The production of seed for the propagation of species is the ultimate aim of every plant; some grow for years, flower, produce their seed

the succeeding summer. In the fall of the year after the rush of spring and the work of summer the plants are content to rest from their labors, having accomplished the task of starting thousands of a like kind on their way.

The Seed.—Each seed is a miniature plant. Locked up within it is laid the foundation of a plant. The outer coverings of the ovule harden and form what is known as the seed-coats; within this and often surrounding the **embryo,** is a food substance, composed mostly of starch, which when it surrounds the embryo is called **endosperm;** sometimes, however, the food may be stored in parts of the embryo as in the **cotyledons** of the bean and peas. The **embryo** is the miniature plant and several of its parts have received names; the little stem is called the **caulicle,** the seed-leaves the **cotyledons,** and the bud the **plumule.**

In a former chapter it was stated that the number of cotyledons in the seed was one of the difference between exogens and endogens; the exogenous plants being spoken of as dicotyledonous plants and the endogens called monocotyledonous; it is seen now that one of the first differences between these two great groups of plants lies within the seed; one having two seed-leaves and the other only one. Some plants, as the pines, have many cotyledons in the seed.

Just over the point oı the caulicle there is a minute little hole going through the endosperm and seed-coats, this is called the **micropyle,** it is through this that the caulicle breaks at germination, also through here that water is absorbed in the beginning of germination, the pollen tube likewise entered the forming ovule through this opening. The scar left on the seed when it broke from its attachment to the plant is known as the **hilum;** sometimes the hilum and micropyle are close together at others they are at opposite ends of the seed. On some seeds as in the bean there is an elevation along the edge known as **raphe,** through this food passes into the developing embryo but when the seed ripens and is detached from the parent plant the raphe becomes functionless.

Germination—Some seeds need a rest of considerable time before they germinate, others will spring to life in a few days. Some species will grow after twenty years or so while others will die in a week or two.

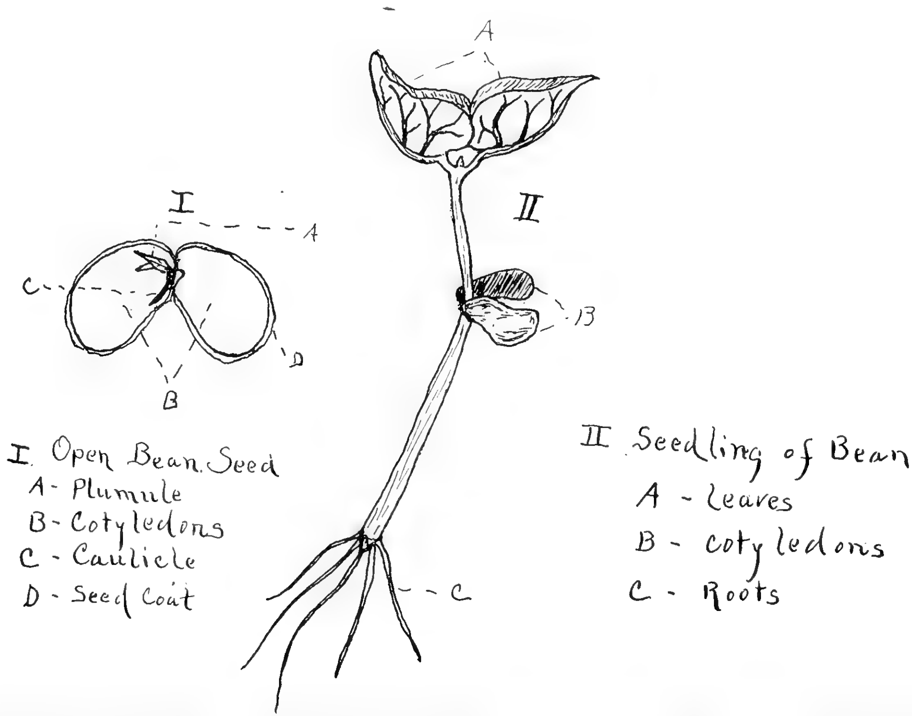
Heat, air (oxygen) and moisture are necessary to make a seed become active. Moisture is first absorbed then oxygen enters and the two make the food substances of the seed soluble so that they can be used by the little plant; warmth hastens activity and gives a

stimulus to growth. During the process of awakening the seed gives off carbon dioxide and uses oxygen; germinating seed also give off heat, showing that there is some chemical process taking place. The caulicle bursts out of the covering and from it comes the first roots; in some plants it then becomes fixed and its further growth forces the cotyledons out of the ground as in the bean; in other species the seed leaves remain underground; from the plumule or bud come the first true leaves. As soon as the plant is established and no longer depends upon the food stored in the seed by the parent plant, but is able to take care of itself, germination is considered over.

Distribution and Number of Seed Produced—If all the seed produced by any one species of plants should take root and live there would be no place on the earth for anything else. Why do plants produce so many seed? Animals nurture their young and protect them, and those species unable to give good protection produce large numbers. Nature expects numerous rabbits to be killed every year but there are enough born to leave some to continue the species the coming season. So it is with plants; they must depend upon numbers to sustain their ,kind. Think how many seed are eaten destroyed or otherwise prevented from germinating; how many little plantlets, even after they have obtained a footing, are browsed off by animals. The higher up in the scale of plant life a series stands the better its methods of scattering seed. One of the families of plants standing highest in the plant kingdom is the compositae., sunflowers, thistles, etc. Have you ever noticed how many weeds belong to this family, daisies, dog-fennel, thistle, dandelion, and many others? They are weeds because they have the power of scattering the species over large areas, the winds can blow their seeds for miles, and though most of the old plants are killed in the fields, still the few left in the fence corners will produce enough seed and succeed in scattering them to such an extent that the whole neighborhood will become infested. There are other things that help to make up a weed, which however, we have not time to mention here.

IX. HORTICULTURAL METHODS OF PROPAGATION.

It has been seen why confidence cannot be put in a seed; in other words, why it cannot be told what a seed will produce; therefore, the horticulturist avoids the use of seeds as far as possible; the florist must in many instances use them, where the plants used are annuals and where cuttings cannot be taken. For garden vegetables seeds must be used; that is why garden varieties run out in a few years and



PARTS OF SEED.

others have to be bred up to take their places. It would hardly be too broad an assertion to state that any variety of vegetables that has been in use ten years is very different from the original first stock. To insure propagating the correct variety, where possible, the horticulturist does so by the use of division or the use of a portion of the orginal plant. The following are some of the methods used: grafting, budding, layering, cutting, stolons, corms, etc.

Grafting—This is mainly used with trees, and in the propagation of fruits. It is the cutting of a **scion** or short twig, from the tree one wishes to grow, and inserting it in a **stock**, usually of the same species. A union takes place and the stock furnishes food for the scion, which grows and bears fruit after its kind. Unions may be expected when plants of the same variety are grafted one upon the other; family unite, beyond this, however, we cannot hope for union. In grafting it is absolutely necessary to have the cambium of the scion in contact with the cambium of the stock, and through it a union between the stock and the scion may take place; no other part of a plant will unite with another. There are numerous kinds of grafts, named after the manner of the cutting of the stock of scion or the portion of the plant used. There are top-grafts, root-grafts, shield-grafts, etc.

Budding—This is simply the process of inserting a single bud of a chosen variety into a stock. This operation is performed at any time that the bark will peel readily. An incision having the shape of a T is made in the stock and the bud is cut so that its cambium will be exposed; it is then inserted under the bark of the stock and securely fastened in. If the bud is put in in June a growth is obtained that year, whereas if the bud is inserted towards the close of the season it remains dormant and grows the following summer. Usually in the South the budding is done in June and the following season or during the winter a part of the stock above the bud is removed and we have a plant budded to a known variety. The bud is placed as near the rgound as it is possible for a man to work.

Cuttings—Some plants may be propagated by cuttings. This method is extensively used—with roses and with several greenhouse plants, A cutting may be made from a leaf as in the begonia, or made from the wood; it will vary in length from one to several inches. The cutting is inserted in sharp sand or in the ground; it puts out roots and eventually becomes a plant like unto its parent. Willow trees, figs, carnation, grapes and many other plants are propagated by cuttings. The time to cut, the place from which to take, the shape of the cutting

and the methods of planting vary with the various plants and cannot be described here.

Layering—This is the covering with earth of a given portion of a plant; this portion then takes root at the different nodes and when it is able to support itself it is cut from the parent plant and the several new plants separated. This method of propagation is used extensively with the scuppernong.

Stolons—A plant that bends over one of its branches, which branch takes root at the tip and becomes a self-sustaining plant, is said to be propagated by stolons. Such a plant is the raspberry. The stolon is cut from the old parent and there is a new plant of the given variety which can be transplanted as desired.

Other Methods—Tubers as in the potato; these can be planted whole or cut into small portions each having an eye or bud. **Bulbs** are also used to continue a variety. In many instances little bulbs, or **bulblets**, are formed by a plant and these will produce full-grown large bulbs in from two to three years or more. Plants producing **corms** are propagated much in the saws way as those having bulbs. Other plants produce **bulblets** as the onion, these bulblets are little bulbs produced above ground, others are propagated by bulb scales, offsets, crowns and various methods.

The underlying principle of horticultural methods of propagation is the taking of some vegetable portion of the plant, and avoiding as far as possible the use of seed which cast a doubt upon the character of the resulting roduct.

X. ORCHARD FRUITS.

After having traced the plant through the various steps in its life, and having made a study of each of the principal parts, we are in a position to take up the study of some of the more important type of horticultural fruits. First, however, let us pause a moment and see exactly what horticulture is.

Horticulture comes from "hortus," Latin for garden, and is the art of growing fruits, flowers, vegetables and decorative plants. The great science of agriculture is divided into several parts, one of which is horticulture. The latter division is subdivided as follows: Pomology, or fruit-growing; Olericulture, or the growing of vegetable:; Greenhousing and Landscape Gardening. Forestry is a division of agriculture, co-ordinate with horticulture.

The most prominent and best known division of horticulture is pomology, or fruit growing. This takes in the production of all the orchard fruits, such as the apple, pear, plum, cherry and peach, and also the small fruits as blackberries, raspberries and numerous others. The word pomology is derived from the botanical name of, possibly the most universal type of fruit; in other words the apple, which botanically is known as a pome.

A Pome is a fleshy receptacle or torus, into which is sunk the one or more carpels composing the ovary. The best known examples of this type of fruit are the apple and the pear. The accompanying illustration will give a better idea of their parts than a description.

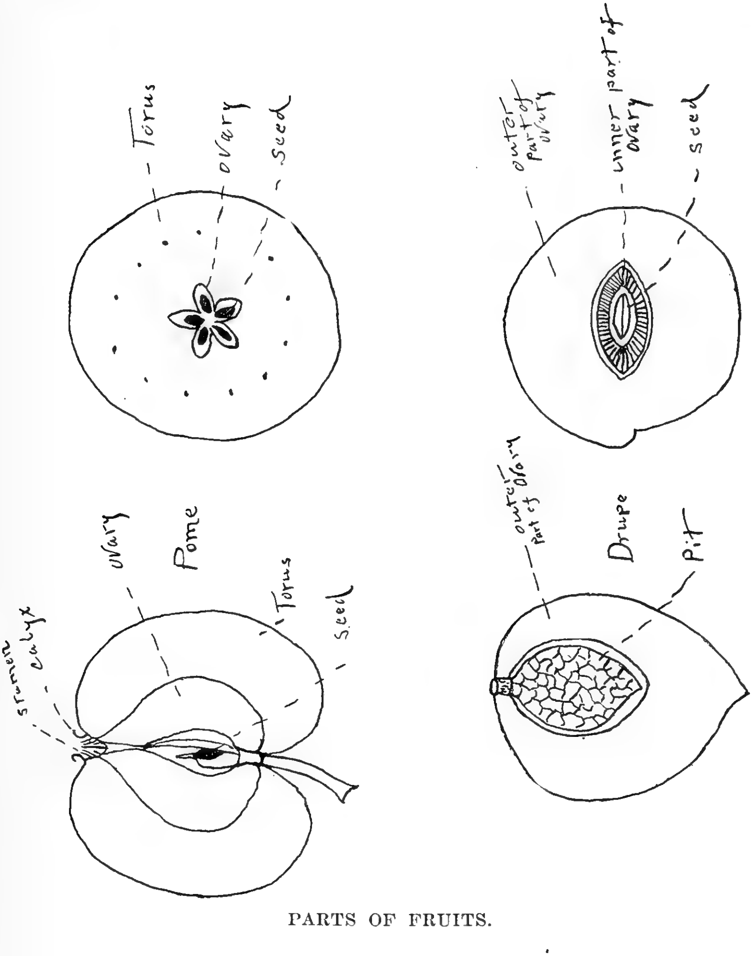
Apples and pears both belong to the same botanical family and genus, but are of different species. The family is the **Rosaceae** or the rose family and the genus is **Pyrus;** the species of our common apple, is however, **malus**, and of the pear **communis.** The development of the pome is easily understood. Ovary is inferior, that is, below the calyx. After fertilization the calyx sometimes drops off, but in most cases persists or remains on the fruit the torus begins to develop around the ovary which usually in the apple and pear is of five divisions. The torus eventually becomes fleshy and forms the greater portion of the edible fruit. The core, or hard center is the ovary, and in the center of this core are found the seeds. Let us now look into the botany of the drupe.

A Drupe is a fruit in which the outer portion of the ovary becomes fleshy and the inner portion becomes hard, forming the pit or stone, in which is found the seed. A drupe is usually a one-celled and one-seeded fruit, being formed from a one-loculed ovary. Examples are the peach, plum, cherry, almond and apricot.

All of the above mentioned fruits belong to the rose family, as the apple, but are of a different genus; their generic name being **Prunus.** Though belonging to the same genus they are all of different species and of some, as the plums, there are numerous species. There are probably more apples grown than any other individual fruit, but taken collectively one would be like to find the production of drupes greater than that of pomes.

A Drupel or Drupelet is a small drupe. There are several fruits composed of drupels, but they are mostly classed with the small fruits and will be treated of in the following chapter. The berries will also be taken up.

Other orchard or tree fruits are the orange, lemon, lime, grape-fruit,



PARTS OF FRUITS.

banana, guava and numerous others, but lack of space makes a detailed botanical description out of the question. Those mentioned above are either torpical or subtropical, some being found only in the torrid zone. Another fruit that might be classed amongst the large or orchard fruits is the pineapple, though it does not grow on trees, still it is large and extensively planted, especially in Florida. It is a **multiple fruit** that is, a congregation of fruits, as each of its oblong, somewhat pointed divisions is a perfect fruit in itself.

XI. BERRIES AND OTHER FRUITS.

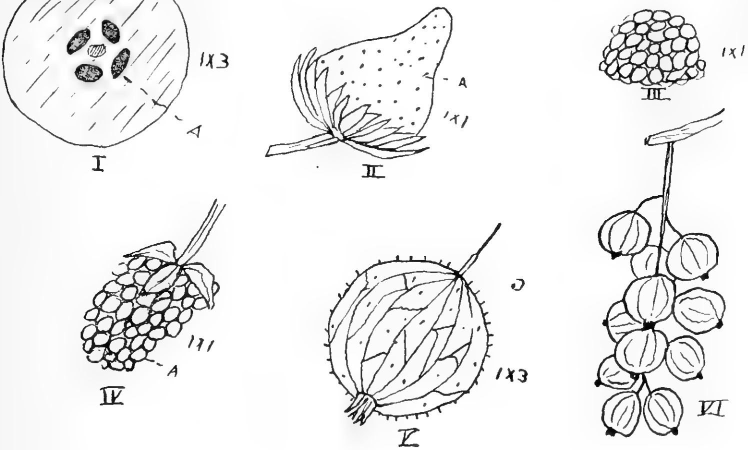
A Berry is a fruit in which the entire pericarp, excepting the skin, is fleshy, the seeds being sunken in the flesh; examples are the grapes, currants, bananas and tomatoes. Horticulturally, however, any small fruit as the strawberry, blackberry, raspberry, etc., is spoken of as a berry.

The grapes belong to the family **Vitaceae** and to the genus **Vitis,** there being several species within the genus, among which are fox grapes, muscadines and European grapes. The plants are climbers, flowering in the late spring; the leaves are simple, rounded and heart shaped; the fruit is a true berry, borne usually in bunchs, though in the muscadines it is often a single fruit. Grapes are generally classed among the orchard fruits and not looked upon as a small fruit.

Gooseberries and currants are both berries and considered among the small fruits. They belong to the **Saxifragaceae** family and to the genus **Ribes;** the two, however are of different species. There are two types of gooseberries ,the plants are thorny and have only from one to three flowers in a cluster. Among the currants there are some three or more species and in contrast with the gooseberries the currant bushes are not thorny and bear numerous flowers in the cluster.

The banana is a good example of a true berry only the seed through long disuse have become abortive. This plant has been propagated so long by suckers that the seed are now of no use to it and it has stopped producing true ones. One of the best and most easily recognized berries is the tomato; though not an orchard fruit, still it holds a prominent place in horticulture.

The **brambles**, though not true berries are classed among the small fruits. The blackberries and dewberries belong to the rose family and are all of the genus **Rubus.** We have the red, black and European raspberries, two species of blackberries and two of dewberries. All of these fruits may be called aggregate, that is, they consist of



I Cross section of grape
A - seed

II Strawberry
A - Akene

III Raspberry

IV Blackberry
A - Druplet

V Gooseberry

VI Currants

KINDS OF BERRIES.

many separate and distinct little fruits; in the case of the brambles these little fruits are drupels or drupelets. In the blackberries and dewberries the drupels adhere to an enlarged torus, whereas in the raspberries the drupels are so insecurely attached to the torus that they easily pull away from it and are seen in the market as a collection of little fruits hollow in the center, giving rise, in the black species, to the name "black cap."

The strawberry also belongs to the rose family, but the genus is Fragaria, fragrant. There are four species of the strawberry, two from Europe, one from Chile and one from the United States. The species from Chile is commonly supposed to be the parent of most of our garden kinds; though the progeny of the others are found in many cases. Like the brambles the strawberry is not a true berry but an aggregate fruit. The red, juicy, edible part is an enlarged torus and the real fruit is found in the so-called seeds, which, however, are akenes; that is, the simplest form of indehiscent fruit. It has been said of the strawberry that: "Doubtless God could have made a better fruit but doubtless God never did."

Horticulture also takes in nut culture, in which class of fruits may be found hazel nuts, hickory nuts, pecan nuts, walnuts, both English and black, and chestnuts; by some the almond is considered a nut but really it is a drupe, like the peach, and the part eaten and thought nut-like, corresponds to the pit of the peach or plum. Nuts are true fruits; the husk found on them, before frost makes it give up its treasure, is the involucre, fleshened and ripened up.

The cranberry is another one of the small fruits, but need only be mentioned as it is not cultivated in the South. Huckleberries also find a place here, but are not cultivated, those found in the markets being the product of the wild plants: this fruit, however, should be improved and cultivated in localities suited to it as it would undoubtedly prove a paying crop.

In glancing over the last two divisions, one will likely be impressed with the number of fruits that belong to the rose family; within its ranks we unquestionably find the major part of our fruits as well as many of our flowers, especially the king of them all, the rose itself. The vine family is also important in horticulture, not for the great variety of fruits but for the one great fruit, the grape; the other families, though of less importance, nevertheless, receive our homage, as each and every one gives to us of its bounty to make life the more enjoyable.

Part IV.

SCHOOL GARDENS.

INTRODUCTION.

we all know the general complaint that boys and girls leave the farm. We know how serious is the promblem of interesting young folks in farm work and farm things.

The garden is a part of farm and country life in which children are most easily interested. Garden work is the easiest and most attractive of farm occupations.

Recognizing these facts, and that the country school should help in the great effort toward holding young people close to the land, "School Gardens" have become a part of the regular school work in many sections of the country.

Great good has already resulted from this movement. Thousands of young folks have become interested in nature, in plant life—in country and land—who were never reached in any other way. One of the most serious difficulties in the way of greatest success has been the lack of teachers and books adapted to leading children along this path.

No such book exists adapted to Southern conditions. Very few Southern teachers have had opportunity themselves for learning how to teach school gardening, however desirous they might be of helping in this great movement.

We hope to provide the missng instructor of teacher and pupil.

The illustrations are from photographs of actual work and scenes in school gardens under the supervision of Professor Stucky while in charge of this work in South Carolina.

We are sure this new effort will be appreciated, but we hope particularly that it will interest the young folks.

We want our young readers to feel that part of the Ruralist belongs to them. The future of this country is in the hands of the young people of to-day. We hope to have some little influence in shaping that future.

VALUE OF THE SCHOOL GARDEN.

In this age of so many studies the addition of any new subject requires serious thought.

The proposed subject must prove its right to be. If it does not fill a place unoccupied by any other subject, it should be denied admission into the school course.

The most casual observer must be aware that there has been a great awakening all over the United States, and other countries, with regard to the teaching of agriculture.

School gardens are bursting into bloom and fragrance in many of the hitherto waste places of the earth. This is well, for He whose first creations centered around a garden, inspired the prophecy that the "wilderness shall blossom as a rose." This result is best attained by keeping the child close to nature, by awakening in him a love for nature so profound that he shall not rest satisfied until he becomes a factor in that transformation of the wilderness into the blossoming-place of the rose.

The School Garden—A Phase of Nature Study.

The value of nature study has become so generally recognized that it is now a part of the course of study in the best schools in every country. Professor C. F. Hodge, in his ideal book, Nature-Study and Life, says: "Nature-study is learning those things in nature which are best worth knowing, to the end of doing those things that make life most worth living." Viewed in the light of this definition, the school garden is a most important kind of nature study. Its place, moreover, in the course of study is easily assured without any squeezing or over-crowding, for it furnishes a center for correlation, providing much admirable subject matter for other studies.

The School Garden—Factor in Adaptation to Environment.

Education in its broadest sense means adaptation to environment.

School gardens are helpful in bringing about this adaptation, for a perfect and complete enviroment cannot take place within the four walls of a school room. The child must get outside, he must see, and study things in their natural surroundings. Bring as much of nature inside as you can, but take the child out to nature as much as you can.

KINDERGARTEN CHILDREN AT WORK IN GARDEN.

In the school garden the child sees nature at home—he watches the silent wonderful unfolding of her laws. The skilled and tactful teacher knows many ways of aiding nature in her teachings—from leading the child from the reverential study of nature to nature's God.

The adaptation to the physical or material environment fostered by this nature study carried on by means of school gardening is readily seen. The child learns to master forces and conditions—he learns to work in accordance with established laws. He becomes adapted to his surroundings, to the end that he may master it—no slave of nature, but the conqueror of nature by possessing her secrets, and making the soil yield rich harvests. He has learned to "dig," hence to the shame of "begging" he will ever be a stranger. He is filled with a lasting confidence that in any stress of circumstances he can always make a livelihood from the soil.

The ethical value of the school garden cannot be over-estimated, The child who produces something, who prepares the soil, plants tne seed, tends the plant with daily care, and at last harvests the results, realizes that he is a co-worker with the higher laws of nature.

One who is himself a producer has greater respect for the productions of others, thus fellow sympathy is developed in the only way really open to the child.

It is claimed that school gardens have transformed slum districts in our large cities, morally, physically, and aesthetically. "School gardens teach among other things," says Dr. Jerrell, "private care for public property, economy, honesty, appreciation, concentration, justice, the dignity of labor, and a love for the beauties of nature." A habit of industry is by no means an unimportant result, when one considers the number of lazy loafers hanging around every street corner, shop and depot—a menace truly to the life of the community.

The economic value of the school garden is easily demonstrated. It is this which has materially increased, and in many cases doubled or tripled the amount produced by the same land. The business experience which comes as the result of harvesting and disposing of the products which are grown is not to be despised.

School gardens furnish the best possible motor education recognized as so indispensable in these days. In rural schools, where other forms of natural training are sometimes impossible, it is an indispensable means of giving expression of thought through action.

The co-ordination of the senses and motor brain brought about by means of school gardening quickens all other lines of school work. The intellectual development resulting from the best use of the school garden has been established by the comparison of work done in other studies by grades which have taken this course and those which have not. Those having the advantages of gardening do much better work in their other studies than do other children in the same school who have not taken the garden work. Quick discrimination is one of the pronodnced intellectual results.

The study of agriculture, the planning, arranging, etc., of a school garden, has its important artistic phase. "The problems of the farm and farming demand as true and as artistic an expression of well ordered thought as do the arts and crafts."

In ennumerating the advantages of the school garden for the pupils of our public schools, one of the more evident, and emphatically one of the most important, is the physical benefit. More than any other phase of school work it promotes the health of the pupils. This would be sufficient reason, if there were no other, for making it a part of our educational system. Incipient tuberculosis, as well as other organic diseases, may be overcome by the safest of all physicians, nature, in the best of all sanitariums—the garden.

MAKING THE SCHOOL GARDEN.

Selection of the Site.

In selecting a site most schools have no choice, as the areas are usually very limited; however, where the teacher has a number of types of soils and elevations to select from, it is preferable to choose a well-drained, sandy loam soil gently sloping towards the south or southeast.

Preparing and Fertilizing the Land.

The success of any school garden will depend to a great extent upon the thoroughness and skill in the preparation of the soil. If the ground is rough and hard, and if a large area is to be worked, it should be deeply broken by a man with team and plow. Then it may be turned over to the pupils for further preparation. If the area is small and the number of pupils very large, in order to give the pupils some physical exercise, along with the knowledge gained, it may be well to have them spade the soil from the beginning. The

FIRST THREE GRADES AT WORK.

length of the work periods each week will usually decide this question. Too much stress can scarcely be laid upon the preparation of the soil. Every clod should be crushed so far as possible, and the first eight or ten inches should be left thoroughly pulverized and well mixed.

Fertilizers.

The chemical improvement of soils embraces the use of fertilizers or manures, the application of which depends upon the type of soil and the kind of plants to be grown.

Plants derive an essential part of their food from the soil. This includes all the inorganic mineral elements found in the ash when the plant is burned, and a very variable quantity of those elements which go off as gas (volatile).

Knowing that different kinds of plants require a special supply of different kinds of plant food, and that most soils are deficient in a number of these elements, we should investigate the needs of the soil and add those elements in the form of barnyard manure or compounded fertilizer. While the soil contains several elements of plant food, most soils are usually more or less deficient in phosphoric acid nitrogen and potash. Due to this common deficiency, almost all commercial fertilizers are valued according to one or more of these three three elements which they contain.

Fertilizers are usually divided into three main classes, namely, those of plant, or animal, and of mineral origin; the two former being organic, while the latter is inorganic. Fertilizers of plant origin include cotton seed meal, leguminous plants (like peas and clovers), or any plant refuse which may be used as a manure. Those of animal origin include the residue of slaughter houses, such as dried blood, bones, scrap, fish scrap, or any other animal refuse which may be had in quantity. Mineral fertilizers are those which are mined from the earth, such as phosphates, kainit, and nitrate of soda.

Commercial fertilizers can be bought and applied separately or in combination. It should always be remembered, however, that they should never be placed in contact with roots or seeds, but should be well mixed with the soil.

The effects of the different elements in a fertilizer upon plants may be mentioned briefly as follows: Nitrogen stimulates the growth of the stems and leaves, and too much nitrogen has a tendency to cause the plant to "run to leaves" at expense of flowers and

fruit. Potash builds up the woody tissue, and stimulates the productions of plump seeds and fruit, and intensifies the color of the bloom. Phosphoric acid aids materially in developing the seed.

For school gardens it is admissable to use commercial fertilizers at the rate of 800 or 1,000 pounds per acre. In addition to this, if available, the soil should have a good dressing of stable manure, which is one of the best fertilizers for a garden. The fertilizers should be spread broadcast and then be thoroughly worked into the soil, with harrow, rake, cultivator or hoe.

Where the parents take a lively interest in the school garden the teacher will often be able to secure a number of loads of stable manuse free of expense to the school.

KIND OF PLANTS TO GROW IN A SCHOOL GARDEN.

The location and size of the garden, the length of the school session, and the methods of managing the gardens during the summer, will, to a great extent, decide the type of plants selected for the school garden. Generally speaking, early maturing, dwarf or bushform type of plants are preferred for the main part of the garden, while climbers and tall growing plants may be used for covering fences or screening unsightly objects.

The main reason for growing bushy or dwarf varieties is, that it enables the pupil to grow a greater number of plants on a small area, thus giving him a larger acquaintance with plant life. Again, dwarf varieties are as a rule earlier in their development, which gives the pupil the opportunity of making the harvests and recording the results before school closes. As to whether vegetable, flowering plants, or field crops should be grown in the school garden will depend on the knowledge and the need of the pupils to be taught. For general educational purposes however, a combination of these plants will usually prove to be most satisfactory. Children of the lower grades are usually inclined to plant large quantities of seed in each row; therefore, plants with large seed should be used for small children. Care should be taken also to select plants easy to cultivate, simple in structure, and those common to the locality.

As children advance they may be given a greater variety, and a more complete type of plants.

THE PURCHASE OF SEEDS FOR THE SCHOOL GARDEN.

A limited amount of school garden seed may be had free by the

teacher applying to the Congressman of the district in which the school is located. However, this source of supply should not be depended upon. The teacher should get catalogs from some reliable seedsmen, select the desirable varieties, and order the seed in bulk. Then, of course, before planting, small envelopes should be purchased, the necessary amount of seed for each small garden be put into these envelopes and the name and variety of plant be plainly written thereon. Then when planting time comes the envelopes should be distributed, each child being given the necessary amount and the right variety for the day's work.

In each packet should be placed a few more seed than is necessary to plant the given row; still the surplus should not be too great, as there will be a danger of developing a lack of accuracy and economy on the part of the child; for it is the natural inclination of the child to plant, in one row, all the seed that have been given him.

The purchase of seed in small packets is very expensive where a purchase is to be made for a great number of children, unless special reduction has been made on these packets for school purposes. Teachers may consult the following seedsmen for prices: T. W. Wood & Sons, Richmond, Va.; Alexander Seed Co, Augusta., and H. G. Hastings & Co., Atlanta, Ga.

FOURTH GRADE PUPILS' NOTES ON PLANTS OF SINGLE GARDEN PLAT.

Rows Nos. 1-2—English peas, Lightning Excelsior; planted March 3; ready to use April 28.

Row No. 3—Irish potato, Irish Cobbler; planted March 3, ready to use May 6.

Row No. 4—Irish potato, Sir Walter Raleigh; planted March 3; ready to use May 10.

Row No 5—Cabbage, Charleston Wakefield; seed sown October 10, 1907, plants transplanted March 3, 1908; ready to use May 20.

Row No. 6—Bush squash; planted April 2; ready for use May 30.

Row No 7—Corn, Early Adams, planted March 10; ready for use June 8.

Row No. 8—Beans, Stringless green pod; planted March 17; ready to use May 20.

Row No. 9—Beans, Kidney Wax, planted March 17; ready to use May 23.

FOURTH AND FIFTH GRADES.

Row No. 10—Beets, Blood turnip; planted March 3; ready to use May 22.

Row No. 11—Radish, Rosy Gem; planted March 3, ready to use April 12.

Row No. 12—Radish, Mixed turnip; planted March 2; ready to use April 15.

Row No. 13—Dwarf Nasturtiums! planted April 10; bloomed May 20.

Row No. 14—Mixed sweet pea; planted March 10; bloomed May 23.

GROUP AND INDIVIDUAL GARDENS.

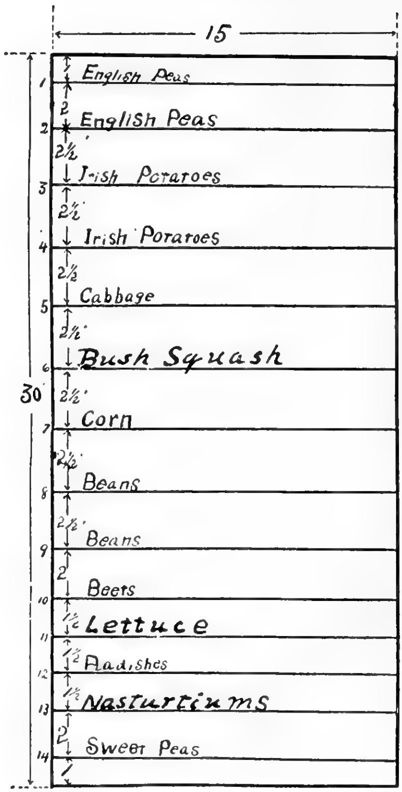
Most experienced teachers in this line of work recommend the individual garden. This is all right providing sufficient time, area and implements for culture are provided; but where the supply of tools is very limited, the area very large, and only thirty minutes per week given for the work, as is the case in some schools, the child would not have time to cultivate his garden. At the same time, four or five children could do the work satisfactorily. Again group gardens enable the children to have larger gardens in which is given more room for using standard size implements, which should always be used as soon as the child has suffiicient strength to manage them.

The group garden has some distinct ethical advantages over the individual garden, but it must not be forgotten that the individual garden teaches the child better business methods, accuracy in individuality, rights of ownership, and respect for the property of others, than does the group garden.

GRADES OF CHILDREN TAKING SCHOOL GARDENING.

As school gardening is one phase of nature study, it has been given, in some of our best schools, from the kindergarten through the ninth grade, the work being regulated to suit the ability of each grade.

The children of the kindergarten, of course, can do none of the heavy work, such as soil preparation, etc., but they can plant seeds, set out plants, water plants, pull up weeds, and have daily opportunities of observing plant growth and other important phases of nature study. If conditions in any school be such that it is impossible for all grades to have gardening, it is recommended that the work be given to the Fourth, Fifth and Sixth grades. Grades younger than these may profitably use the garden for observation work along



Plan of Single Garden Plat for 4th Grade Pupils.

with other phases of nature study. Grades older have had enough practical experience in the garden to be able to use a text-book on the subject with advantage.

TOOLS FOR THE SCHOOL GARDEN.

The tools for the school garden should be principally the same as those recommended for a home vegetable garden. Light tools are recommended for small children, but toy tools are very unsatisfactory and should never be relied upon.

Each individual garden plat should have one rake, one hoe, one garden or push plow, one hand trowel, one 50-foot measuring tape, one garden line, and a watering pot. By skillful management, on the part of the teacher, however, many of these implements may be used in common, thus avoiding the expense of buying so many full sets.

These implements can usually be purchased at almost any hardware store. For the purchase of garden plows teachers may save expense by ordering them from B. F. Avery & Co., Atlanta, Ga., as this company makes a reduction on implements sold to schools.

FALL WORK IN THE SCHOOL GARDEN.

In the South, where the climate is mild, and where many plants can stand outdoor conditions during the winter without serious injury, school gardening can be successfully carried on during the entire year.

When the period opens in the fall, the soil should be fertilized and well prepared, then the pupils may set violets, plant narcissus bulbs, and fall onions. Sow such seeds as winter radishes, spinach, lettuce and endive.

These vegetables will endure ordinary frost, and some of them will remain in good condition, and ready for use, in the open garden all during the winter.

A little later in the fall, say about the 10th of October, it may be well to sow cabbage seed in the open garden, in order to have plants for early spring setting. Sweet peas may also be sown, rather deeply and continuous in the drill, for early spring blooming. Fall-sown sweet peas may be expected to bloom a month earlier than spring-sown peas.

The fall season being the best time to sow lawn grasses, it is well for the teacher to have the pupils design walks, locate places in

GARDEN PLOWS AND HAND TOOLS FOR GARDENS.

which to set trees, prepare the soil and sow grass seeds for the lawn, thus giving them some practice in landscaping, as well as the regular school garden work.

HOTBEDS AND COLDFRAMES.

By the proper construction and management of hotbeds and coldframes vegetables and flowers may be successfully grown during the entire winter. The sash for covering these frames may often be secured, at little or no cost, from some patron of the school, who may have old sash removed from a building. For structure and management, Professor J. S. Newman, in his "Southern Gardeners' Practical Manual," says: "Excavate to the depth of eight inches an area three feet three inches wide by five feet eight inches long." (As many of these as is necessary for the school may be made in one continuous bed, letting the long way of the sash extend across the bed.) "Fill this excavation with fermenting stable manure and green cotton seed mixed in equal parts, moisten it and stamp down smoothly, moisten the material as it is mixed, and again when put into the pit if it seems dry.

"Construct a close frame of one and one-half inch heart lumber to fit over this pit. Have this two feet high at the north end and one foot high at the south end, the sides sloping uniformly. The heat will be retained better, and the cold air excluded, if soil is banked around the lower part of the plank. When the frame is completed and placed over the manure, fill in to the depth of four inches with sifted dark sandy loam and put on the sash. In three or four days remove the sash, sow the seeds, water gently, and replace the sash. When the temperature in the hotbed gets above 70 degrees Fahrenheit ventilate by placing a block of wood under one end of the sash, and during warm days the sash may be removed entirely. Keep the surface of the bed moist, but not wet, for such crops as lettuce try to let the temperature range between 45 degrees Fahrenheit at night and 65 degrees Fahrenheit during the day. It should be remembered that a hotbed loses its heat within about six or seven weeks and should be refilled where continuous planting is desired.

"The coldframe is made the same way as the hotbed, excepting that rich earth is used instead of the thick layer of manure which supplies the heat for the hotbed. If glass is too expensive for the coldframe, white cloth may be substituted, as a cover, with fair results.

"The hotbed is used for growing lettuce, radishes, nasturtiums, etc., during the winter, and for starting tender plants such as peppers, egg plants and tomatoes for early spring setting.

"The coldframe is used for hardening off rather tender plants for setting to the open ground, and for growing rather hardy plants, such as winter radishes, lettuce, beats, carrots, endive, etc., during the winter and early spring."

Many other lines of work, such as the study of flower structure, window gardening, the construction of hotbeds and coldframes, may be begun in the fall and continued throughout the winter.

WINTER WORK.

This being a season when weather conditions are usually unfavorable for outdoor work, the most of the time may be consumed with laboratory exercises—the production of plants in hotbeds, coldframes and window boxes.

LABORATORY EXERCISES.

While it is essential and best to take the children out of doors to do much of their practice work, some of the important principles of agriculture do not lend themselves to this method. There is need of some laboratory work which can easily be performed in doors, during the winter season.

Much material for these exercises may be collected by the pupils free of cost. Some good experiments can be performed with a collection of empty tin cans, buckets, bottles, wooden boxes, the different types of soils, etc. Then with a small appropriation from the school board for the purchase of a few dairy thermometers, test tubes, a set of metric weights, an alcohol lamp, some cork bottle stoppers, glass tubing, rubber tubing, etc., the teacher will be able to perform more interesting and profitable experiments.

With the above-mentioned material the teacher can perform laboratory experiments showing the escape of moisture from plants, that the soil contains plant food, the habits of plant growth, that plants require air to form roots, the capacity of soils for taking in and holding water, the rise of moisture in the soil, the effects of light on plants, and the different methods of plant propagation.

It is essential that the pupil know something of the structure of the common plants; that they should know the names and understand, to some extent, the functions of the essential parts of the

SCHOOL CHILDREN TESTING SEEDS.

common plants. This study may be made in the early fall, or, if the specimens can be had from window boxes, it may be done in midwinter.

Simple plants should be selected for the lower grades, and only the very general parts, such as roots, stems, leaves and flowers studied. While technical terms in this work should be avoided as far as possible, yet scientific facts should be adhered to.

The higher grades should be given a more technical and detailed study of the plants, laying special stress on the names and functions of the different organs of the flower, such as stamens and pistils, anthers and stigmas.

This study will interest the child and induce him to make a further study of the needs and environment of plants.

THE STUDY OF SEEDS.

The majority of our garden vegetables, flowering plants, and field crops being propagated by means of seeds, it is very important that the child should be made as familiar with the names, structure and uses of these seeds as may be possible.

(a) **Germinating Seeds**—Take a tin plate, two circular pieces of cloth, preferably cotton flannel, cut to fit into the plate, and a pane of glass large enough to cover the plate. Then count out fifty or a hundred of the seeds to be tested, spread them on this cloth, and cover them with the other piece of moistened cloth.

Next place the pane of glass over the plate, to prevent evaporation of moisture, and set it aside where it will remain at ordinary living room temperature. When these seeds begin to sprout, have the children to count out those germinated and make such calculations as the children are prepared to make. This is one good method of teaching percentage, and other practical lessons in arithmetic.

Many of these plates may be had and let the children make several tests as regards:

Maturity of seeds, Age of Seeds, Size of Seeds, Temperature Required for Germination, Moisture Required for Germination, Plant Food in Seeds, Position of Seeds—germ end up or down, Color and impurities in seeds, as grass and weed seeds.

Some of these experiments will give better results if the tests are made in pans of moist sand.

(b) **Depth of Planting.**—A further study of seeds may be made by securing a few big mouthed bottles, or pint jars, and planting seed

at various depths in these bottles filled with moist loamy soil. This will show the best depth for planting, the habit of root growth (this may be seen through the glass), and the depth of soil through which the germ of the seed is able to come.

SPRING WORK.

School gardening should be begun during the latter part of February or the first part of March.

After the soil has been thoroughly prepared and well fertilized, seeds of such plants as spinach, garden peas, endive, and radishes may be sown, onion sets may be planted, and cabbage plants either purchased or from the fall sowing, may be set. Sweet peas, for bloom, may also be planted very early. The sowing of these may not be necessary, however, if a sufficient amount was planted the preseding fall. Next in order may be planted the seeds of such plants as corn, lettuce, turnips, and Irish potatoes.

During this time it is well to have seeds of the common flowering plants, and some of the more tender garden vegetables, sown in window boxes or hot beds where they will be protected from frost, thus enabling the school to have flowers and vegetables earlier in the spring.

Where many children are to be instructed in the garden at one time, it is well, so far as posisble, to have all the garden plants to be worked by these children extend in one continuous line, then one long garden line may be stretched across the entire number of plats and the children or child of each plat be required to lay off the row to this line, which makes the garden look more attractive when the seeds germinate. When the first row has been completed the entire line may be moved over and the second row laid off, and so on for any number of rows. Other grades working together may have their garden plats parallel with and joining those first laid out, and by the time all are given plats the whole area will be in the form of a square or a parallelogram; this, of cource, depending upon the available ground.

Each child above the third grade should be required to keep a note book and record such facts as dates of planting, methods of planting, dates of germination, when ready to harvest, the yield, etc.

While the commercial or monetary side of school gardening should never be stressed, still the children should be taught the best methods of procuring the most and best vegetables on the given area, and

should be allowed to sell the garden products to obtain funds for a good cause, such as improving the school room or the school grounds.

COURSE OF STUDY.

In preparing a course of study for nine or ten grades, it will be found a difficult matter to make clear-cut distinctions between the work of one grade and that of the next higher. In fact the subejct matter of the primary grades is pretty much the same only there is a deepening and widening of the subject and more independent work on the part of the pupils. In schools where conditions do not favor a very close grading, the primary grades can very well be taught together. An able and efficient teacher who understands the differences in the development of the children can so plan the work that all will be interested, while each child is required to do such work as he can do successfully. In garden work the children of the third and fourth grades can plan and lay off their own garden beds—children of the first grade can lay off rows in beds which have already been prepared for them.

It will usually be found not only beneficial, but essential, to have the sixth and higher grade use some good elementary text books, such as "Agriculture for Beginners," by Burkett, Ginn & Co., New York, and "Agriculture for Southern Schools," by Duggar, sold by Macmillan Co., New York.

FIRST GRADE—FALL WORK.

1. **Seed gathering** (a) Flower seeds, (b), garden seeds, (c), tree seeds, (d), seeds of wild plants.

2. **Bulb Planting**—(a) Soil type, (b), distance, (c), depth .

3. **Making of Window Gardens**—(a) Boxes sloping towards sun, (b) Planting of common plants, such as (1), Geraniums, coleus, asters, sweet peas, etc.

4. **Fall Gardening.**

WINTER WORK.

1. Raising vegetables in hotbeds and coldframes for winter use.

2. Study of soils—clay, sand, loam, etc.

3. Seed testing.

(a) Count seeds, (b) Apparatus, (c) Number Germinated, (d) Number failed.

. Sowing seed indoors for spring transplanting.

SIXTH AND SEVENTH GRADES.

SPRING WORK.

1. Soil preparation (a) Plowing or spading, (b) Fertilizing, (c) Laying off rows with garden line, (d), Sowing seeds, (e), Thinning, (f) Cultivating, (g) Gathering.

SECOND GRADE—FALL WORK.

1. Seed gathering continued.
2. Classification of seeds according to natural methods of distribution as by (a) Wind, (b) Animals, (c) Water.
3. Fall gardening. (a) Some ornamental plants as, (1) Violets), (2) Bulbs, (b), Study of bulb structure, (c), Planting a few fall and winter vegetables, such as (1) Lettuce, (2) Spinach, (3) Turnips, (4) Radishes, (5) Endive), etc.

WINTER WORK.

1. Similar as for first grade, more stress being put on independent work of pupils.

1. Similar to first grade, using a greater variety of plants and requiring more individuality in the work.

THIRD GRADE—FALL WORK.

1. Seed gathering and classification according to economic value of plants.
2. Fall gardening continued.
3. Window gardening, the influence of light, heat, and moisture on plants studied.

WINTER WORK.

1. Raising of vegetables in hotbeds and coldframes—(a) Culture, (b) Uses, (c) Value.
2. Study of soils continued, giving demonstrations of,—(a) Cappillarity, (b) Porosity, (c) Texture.
3. Seed testing continued.
4. Sowing seeds in hotbeds, coldframes or window boxes for spring transplanting to gardens.

SPRING WORK.

1. Gardening continued—(a) Preparation of soil, (b) Fertilizing, (c) staking out gardens and drawing plan, (d) Planting seeds, (e)

Transplanting plants from Hotbeds (f) Depth and distance of planting, (g) Cultivating ,(h) Harvesting and yield.

FOURTH GRADE—FALL WORK.

1. Seed gathering.
2. Classification and methods of storing and preserving seeds.
3. Fall gardening continued—(a) Testing adaptability of vegetables to low temperatures.
4. Window gardening—(a) Fertilizer experiments with different plants. (b) Depth of planting seeds.

WINTER WORK.

1. Hotbeds and coldframes (a) Construction, (b) Calcualting dimensions of covers.
2. Seed testing acording to,—(a) Size, (b) Color, (c) Maturity, (d) Age, etc.

SPRING WORK.

1. Similar to work of third grade, using a slightly more complex type of plants.

FIFTH GRADE—FALL WORK.

1. Seed gathering continued—(a) Classification, (b) Identification, (c) Preservative materials for winter storage of seeds.
2. A collection and the study of a few of the common insects.
3. Fall gardening continued, as—(a) Preparation of soils and Designing beds for bulbs and violets.
4. Window gardening continued with a comparison of indoor with outdoor grown plants.

WINTER WORK.

1. Hotbeds and coldframes continued as,—(a) Management with reference to controlling the temperature, (b) Best soil for, (c) Kinds of vegetables suited for forcing.
2. Soil continued—indoor experiments. (a) Drainage, (b) Water holding capacity of the different types of soil, (c) Effects of humus on texture of soils, (d) Influence of water on temperature of soils.
3. Seed sowing for spring transplanting continued.
4. Pot experiments with fertilizers.

SPRING WORK.

1. Similar to fourth grade work, more stress being put on the keeping of accurate and neat records of all work done.

SIXTH GRADE—FALL WORK.

1. Harvesting and recording yields of all crops found on gardens at beginning of session.

2. Removing of old plants from garden, (a) Sowing seeds so as to practice crop rotation. (b) Designing walks and sowing grass seeds for lawns.

3. The collection and study of insects continued.

4. Pruning begun.

WINTER WORK.

1. Study of animals begun, (a) Horses, (1) Draft, (2) Trotting; (b) Cattle, (1) Dairy, (2) Beef; (c) Poultry, (1) Eggs, (2) Meat.

2. Fertilizers,—source of and how valued. (a) Nitrogen, (b) Phosphoric acid, (c), Potash.

3. Plant propagation by, (a) Bulbs, (b) Corms, (c) Cuttings, (d) Grafting, (e) Rootstocks, (f) Seeds, etc.

SPRING WORK.

1. Plant structure, (a) Cells, (b), Stems, (c) Roots, (d) Leaves, (e) Inflorescence.

2. Gardens continued, stressing the plants and seed selection for improving the varieties.

SEVENTH GRADE—FALL WORK

1. Fall gardening continued, stressing the importance of adding humus and plant food to the soil.

2. The collection and the classification of insects according to beneficial and injurious species.

3. Make landscape plans for the school grounds, (a) Locate places for trees, shrubbery, drives, etc.

4. Pruning continued.

WINTER WORK.

1. The study of animals continued.

2. Animal products, as their value, preservation and management. (a), Meats, (b) Eggs, (c) Butter, (d) Milk, (e) Cheese, (f) Care of dairy products in general.

3. Grafting. (a) Whip or tongue, and cleft grafting.

4. Budding. (a) Shield, and annular budding.

5. Cuttings. (a) Hard wood, soft wood and leaf cuttings.

6. Commercial fertilizers continued, (a) Composition and value.
7. Indoor seed sowing for spring transplanting continued.

SPRING WORK.

1. General classification for economic plants. (a) Cereals, (b) Legumes, (c) Grasses, (e) Roots, (f) Fiber plants, (g) Oil plants, etc.

2. Preparation and application of insecticides and fungicides. (a) Bordeaux mixture, (b) Kerosene emulsion, (c) Paris green, etc.

3. Spring gardening continued, requiring the pupils to grow a more complex type of plants.

EIGHTH GRADE—FALL WORK.

1. Landscape plans for school continued.

2. Seed selection with introducmtion to plant breeding in connection with fall gardening.

3. Study of insects continued.

4. Study of the plant continued, (a) Composition, (b) Structure, (c) Physiology, (d) Heredity, (e) Environment, (f) Pollination, (g) Hybrid, (h) Cross, etc.

WINTER WORK.

1. Spring gardening continued. In this, some special crop of the locality should be grown and studied. (a) Variety tests, (b) Soil and climatic influences.

This work should be done with the constant aim in view of improving the plants by systematic methods of plant breeding.

NINTH GRADE—FALL WORK

In this grade more elective work may be allowed, and more stress placed on those subjects best adapted and most needed to meet the local conditions and necessities of the school and community.

WINTER WORK.

More laboratory work should be planned and performed by the students, which will prepare them for doing more effective spring work in the gardens.

SPRING WORK.

The study of individual crops, varieties of plants, the soil, and climatic conditions should be continued, stressing those points which are most upbuilding to the pupils and to the community in which the school is located.

WORKS OF REFERENCE.

Teachers should apply to the Agricultural Experiment Station and ask that the school receive copies of all the bulletins issued by the station. They should also write to the United States Department of Agriculture, Washington, D. C., for the following:

1. List of bulletins and circulars for free distribution, Division of Publications, Circular No. 2.
2. Farmer's Bulletin, Subject Index, Division of Publications, Circular 4.
3. Bulletin No. 160, School Gardens, Office of Experiment Stations.
4. Bulletin No. 186, Exercises in Elementary Agriculture, Office of Experiment Stations.

Books for reference:

1. Hemenway, H. D., "How to Make School Gardens," Doubleday, Page & Co., New York.

3. Hodge, C. E., "Nature Stury and Life," Ginn & Co., New York.

4. Newman, J. S., "The Southern Gardeners' Practical Manual." This is the best and most indispensable reference book on growing vegetables and small fruits under southern conditions. It may be obtained from Professor J. S. Newman, Clemson College, S. C.

PRODUCTS OF THE SCHOOL GARDEN.

Part V.

PLANNING AND CARE OF SCHOOL GROUNDS.

Introduction.

It is in the school house with its surrounding grounds that the foundation of America's future greatness is laid. The sensitive children, some of them leaving home with eagerness to enter this new world, others in fear and trembling of the unknown difficulties that lie within the school gate, are the material of which the teacher must make future citizens. During this plastic state of childhood impressions are easily made and ideas quickly formed either for better or for worse. It is easier to favorably impress, or otherwise, the seeking mind of the child than it is to erase the impressions after they have been made. It is plainly the duty of the teacher, the Board and the parents, to influence the rising generation to higher ideals, higher standards of honesty, higher desires for an education, a greater love for beauty and nature so that eventually the ideal American citizen shall be formed.

It is too often the case that some progressive young teacher with a large stock of energy and the desire to better her or his pupils, is held back by an unsympathetic and unresponsive Board or parent.

In many sections it is necessary to start the planning of the school grounds by a systematic canvass of the community, and stirring the public opinion in favor of the betterment of the school. In many localities the educating of the public is almost as important as that of the child and is attended by many more difficulties. Even though the teacher does not think it possible to so stir the minds of the adults in the community as to immediately obtain the desired funds and cooperation, he or she should not be deterred from starting the campaign. There should exist a bond between all rural school teach-

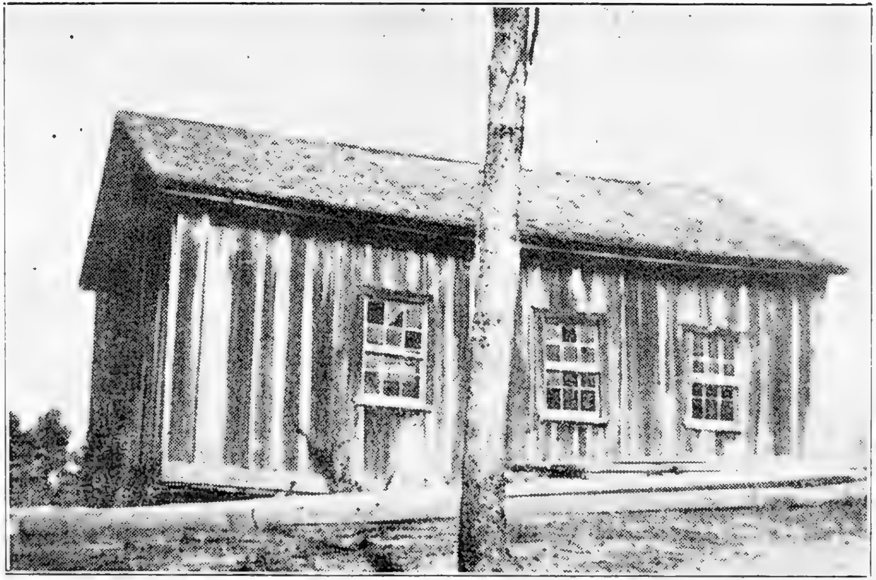
ers so that one might continue the well thought out plans of the other and carry to success a project which should be desired by all alike.

The expense attendant upon the decorating of the school grounds, though very little in itself, may deter many Boards from taking hold of the work as they should. If, however, the one in direct charge of the school building and its surroundings makes efforts to beautify and improve them, they will doubtless find that within the course of a few years some money will be found available for the purchasing of plants and the care of the property. Many localities will not believe a thing until they see it, and if through the hard work of the instructor the forbidding and uncongenial grounds surrounding a district school gradually take on a charactr of beauty and refinement, there will be some neighbor or some member of the Board sure to notice the change and be willing to start a campaign in favor of the "School Beautiful." There is assuredly some person in nearly every neighborhood who understands the influence that trees and flowers, well kept lawn and gravel paths exert upon the up-coming generation of youths, who will be able to realize that as the expenditures for the school increase, those for jails, poor-houses, and other buildings of like character decrease.

There is nothing that so appeals to the developing child as the beauties of nature. It is the teachers duty to keep children who begin school with joy and gladness in that condition throughout their school career, so that they may carry into the world a remembrance of happy school days and be better men and women for the same. Likewise, it is also incumbent upon the teacher to so handle the child who first comes to him or her with fear and dread that such feelings shall be removed, and the pupil continue in school with joy and gladness, so that the little fearful youngster may eventually go out into the world and fill his or her place to the best advantage of the country and community. There is nothing that will so add to the ease of teaching, to the increase of learning, and the joy of living as a well planned and beautifully kept school ground and a comfortable and attractive school house.

THE SCHOOL HOUSE.

Of necessity the school house must be the central object within the school grounds. Figure 1 shows a type of country school that has been and is too often met with within our rural district. A more



1. RURAL SCHOOL—AS IT WAS.

forbidding building, a more uncongenial place in which to study and improve could hardly be picked out. The school house in a great measure gauges the prosperity and the intellectuality of the community. A building in which the windows are broken and dilapidated, the sides of which are open to wind and rain, of which the floors are full of holes and made of undressed boards, might be a well ventilated building but could scarcely be considered an up-to-date school house. One of the first points to be desired in a school building is simplicity. Avoid all "jim crack" types of architecture and make the building appear in keeping with the surroundings. If an opinion upon the subject had to be given it would probably not be incorrect to state that the school house should be the best building in the community. The money, however, should not be put into fancy gables, odd shaped windows, and poorly constructed rooms, but should be saved and used for good heating, comfortable desks and chairs, solid tables and good equipment in all lines. It should be expended to secure good ventilation, to keep the building painted and in good repair.

Figures 2 and 3 show the types of school houses that we are glad to say are rapidly taking the place of the former kind. Figure 2 is a particularly good type of rural school as it is not expensive and is pretty, being substantially built and serving all the purposes of a school house. Figure 3 also is a good type though possibly not so attractive in appearance as Figure 2. In planning the house care should be taken to give good light to all the recitation rooms, as the eyes of the children must be protected for they are to be used extensively if an education is to be obtained.

Ventilation is also an important factor. Children can not study in the heavy atmosphere of a poorly ventilated room; but in procuring fresh air we must be careful not to make the room too cool, for though poor work is done in vitiated air poor work is also done when the room is too cold or too hot.

GENERAL PLAN FOR SCHOOL GROUNDS.

It is too often the case that a rural school is placed in a most forbidding situation, and the grounds are entirely too small for the healthly, romping exercise of the growing boys and girls. Baseball and football cannot be played on a small lot, and school without sports is almost no school at all. It has often been a riddle why school houses in the county were not surrounded with ample ground. It can be understood in the city where land is very valuable and

is sold by the foot, but why the district school should be built in some old forsaken corner or on top of some cold, drear hill with practically no ground surrounding it, is hard to understand. Land in the country is comparatively cheap and no better use can be made of it than to turn it over to the future farmers for their enjoyment while they are young.

The rural school teacher always has a great opportunity of planting and improving the school grounds. It is almost safe to say that the mere request will obtain for the school sufficient ground for all purposes. Therefore, let us avoid as far as possible the cramping of the school ground, but expand them so that there will be room for both work and play. The school house must of course be the central figure. The exact position that it should hold must be determined by the shape of the lot. Where practical it is advisable to move the school house as far back from the road as possible, putting most of the play ground in front, also removing the building from the dust and dirt of the highway and the children from the distraction of the ever-passing teams and people. It is also well to separate the yard into divisions—one for the boys and one for the girls. This may be done in several ways, either by the use of hedges, walks, strips of grass, or any other way that would make a good distinguishing mark, for invariably the boys and girls are slipping back and forth across the line. The boundary of the school grounds may be well marked with shrubs, trees or even hedges. The out-buildings should also be screened with plants. Flowers are not always desirable or essential in the landscaping of the school. Often they are more of a detriment than otherwise, but out of the way corners which are little used or frequented may be turned into flower beds. The walks on the school grounds should be straight, going directly from one point to another and should follow the paths made by the pupils going to and from school or from one frequented point to another on the school ground. Generally speaking, it is not advisable to have too much planting; too many fancy bushes and trees; too many flowers around the school that often get in the way and are seriously injured do not tend to form a love for them in the breast of the boys, but rather a dislike. In the general planning of the school ground, everything must be done to bring the children to a realization of the beauties and pleasures attendant upon a knowledge of plant life or by being surrounded with plants. Likewise everything must be avoided that will tend to raise a dislike or repugnance for nature and her trees and flowers.

Many have found trouble in making the boys, particularly, of a school protect and look after the plants about the building. One can almost fancy that where such troubles happen there were many plants in the way of the games and with the placard on them "Do not touch," or "Do not pull," or that some boys have been punished for accidentally falling over a sapling and injuring it. Such accidents happen, and instead of punishment it would be far better to make pupils repair the damage done, and nurse the plant to health, rather than give them demerits or make them learn lines of poetry because the plant has been injured.

The uses, kinds, care and ways for planting of the different materials that may be used in landscaping of the school will be discussed in detail under the following heads:

I. TREES.

Around every school house there should be some trees. If you are unfortunate in having no native forest trees in the school yard it becomes necessary to plant them. A great many schools follow the custom of having an arbor day and numerous trees are set out and protected by stakes and in other ways. The small trees usually are fallen over, torn up or broken down during the school year or die from neglect during the summer, and at the next arbor day they all have to be replanted. It would be far better instead of planting a lot of small saplings to plant one or two trees of good size. These should have good, substantial root systems and be set well into the ground so that they could take care of themselves and within a few years begin to lend their shade and beauty to the school grounds.

Mr. J. H. Prost, City Forester of Chicago, gives the following reasons for planting trees:

"1. Trees are beautiful in form and color, inspiring a constant appreciation of nature.

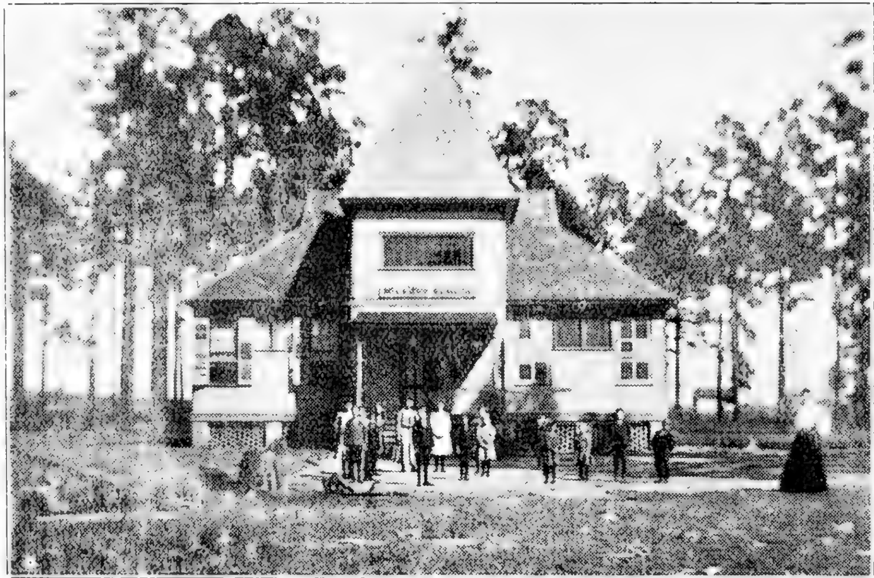
"2. Trees enhance the beauty of architecture.

"3. Trees create sentiment, love of country, State, city and home.

"4. Trees have an educational influence upon citizens of all ages, especially children.

"5. Trees encourage outdoor life.

"6. Trees purify the air.



AS IT IS—READY FOR WORK ON THE GROUNDS.

"7. Trees cool the air in summer and radiate warmth in winter.
"8. Trees improve climate, conserve soil and moisture.
"9. Trees furnish resting place and shelter for birds.
"10. Trees increase the value of real estate.
"11. Trees protect the pavement from the heat of the sun.
"12. Trees counteract adverse conditions of city life."

All of these reasons are not applicable to the rural school but many of them are, Nos. 3, 4, 5, 9 and 10 especially. As a rule trees should be grouped instead of planted in rows. It might be preferable to bound the property with trees, or better yet to plant groups in each corner of the yard and possibly one or two groups near the building. Specimen trees, that is, those planted alone, are not very desirable in the ordinary school yard, but are more often used upon a College campus and in parks. Be careful in planting trees near the building not to interfere with the light, but so arrange them that they do not come in front of the windows, except upon the sunny side of the building where their shade is desirable. Also in using trees about the school do not put them in the center of the playground, as they obstruct the games of baseball, basket ball or football. A large sheltering tree, however, in the corner makes a fine place for the spinning of tops, the shooting of marbles, or the pitching of quoits.

It may be of advantage just here to say something of the evergreens. A few of these trees judiciously used in the school yard will lend color during the winter months, but too many of them give a dark, gloomy appearance to the property that is not advantageous to the pupils. Some of the best trees for use in our section for planting around the school are as follows:

KINDS OF TREES RECOMMENDED.

Norway Maple	*Acer Platanoides*
Red Maple	*a. rubrum*
Locust	*Robina preudacacia*
China-berry	*Melia Azedarach*
Japanese Varnish tree	*Herculia platanfolia*
Sweet-gum	*Liquidambar Styraceflua*
White Oak	*Quercus alba*
Live oak	*Q. Virens*
Sycamore	*Platanus occidentalis*
Carolina Poplar	*Poplar Carolin*
Tulip tree, erroneously called poplar	*Tiriodendron tulipifesa*
*Large Flowered Magnolia	*Magnolia grandiflora*

*Juniper or Red Cedar .... *Juniperus Virginiana*
*Deodara Cedar .... *Cedrus deodara*
American Elm .... *Ulmus Americana*
*Evergreen.

These trees, all except the evergreens, should be transplanted during the fall and winter. It is advisable to take them up with as many roots as possible and with as large a trunk as can conveniently be handled. The hole should be dug and some soft dirt, well mixed with decomposed barn-yard litter, should be placed in the bottom. The tree should then be planted and have the dirt well stamped down around the roots. The top should be pruned back to correspond with the loss of root area. Do not fear cutting back the top of a transplanted tree too much. As a rule it is hard to get people to prune a newly planted tree sufficiently; they usually leave too many branches upon it and it makes a poor and sickly growth the following year.

The care of forest trees is not of great importance. There is nothing much to do to them except to remove limbs that have been broken by storms, apply white lead to the splits, cracks and all injured or broken places in the bark. The tree in the school yard requires very little attention after it has become securely established. Evergreens should be transplanted just as the new growth is beginning in the spring. Pruning is also necessary when transplanting them; however, they are not usually cut back so much as a deciduous tree. Their after care amounts to very little unless some accident should happen.

II. SHRUBS.

Shrubs may be used to great advantage around the school. They are small, and, therefore, do not cut off the view. They are inexpensive, grow rapidly and give good effects in a short time. The places in which they may be used are innumerable. The division line between the boys' and girls' playground may be formed by clumps of shrubs, and they should be used to screen out-buildings on the school ground; they serve a great purpose in bringing the school house, itself, in contact with the ground; that is, by being planted around the base of the building. They may be grown under the trees, in the corners of the yard, may be used to hide unsightly fences, to take the places of trees where these would be too high, and if desirable the yard may be bounded by shrubs and hedges. Care should be taken not to plant shrubs where they are apt to be run over or brushed against as they are small and offer but little resistance to the fierce rush of boys after

the football or in some other game. A judicious selection of shrubs will give a wealth of beauty and bloom from the early spring through the summer into the fall. These plants are so numerous that it seems a hopeless task to mention those that should be used. Some of those that grow to advantage are as follows: Dog-wood, Japanese quince, Hydrangea, mock-orange, the sumach, elder, the bridswreath, spiraea, Thunbergs spiraea, Van Houtt's spiraea, lilacs, Japanese snow-balls, the various roses, the banana shrub, the gardenia or cape jasmine, the tea-olive, California privet, Euonymus and others. Some of these are grown mainly for their flowers, others for their foliage, and some such as the California privet and the Euonymus are mainly used as hedge plants. There are numerous others which are evergreen such as the arbor vitae, biotas, and other coniferous ones, which, however do not do so well in southern sections, but may be used to advantage in the northern parts of Dixie land. Shrubs, as a rule, need very little care and live from year to year. If, however, some of them become infected with plant lice or insects it may become necessary to spray. The Japanese quince is quite a host for the San Jose scale, and, therefore, in fruit growing sections it might not be advisable to use this shrub around school houses.

These plants had best be put in groups and not singly. The greatest use for the shrubs will probably be found as screens around outbuildings and around the base of the house, and possibly along the fence. In setting out these plants, it is advisable to have the ground in fairly good tilth, and where it can be obtained, stable litter can be worked to in good advantage. The pruning of shrubs at setting out time is like that of the trees. After that the bushes and the trees are only pruned to keep them within bounds.

LIST OF SHRUBS.

Dog-wood	*Cornus Florida*
Japanese Quince	*Cydonia Japonica*
Hydrangea	*Hydrangea*
Mock-orange	*Philadelphus*
Sumach	*Rhus Glabra*
Elder	*Sambucus Canadensis*
Bridalwreath Spiraea	*Spiraea*
Thunbergs Spiraea	*Spiraea*
Van Houtt's Spiraea	*Spiraea*
Lilac	*Syringa vulgaris*

Japanese Snow-Ball .... *Viburnum Tomentosum*
Roses .... *Rosa*
*Banana Shrub .... *Magnolia Fuscata*
*Gardenia or Cape Jasmine .... *Gardenia Jasmenoides*
*Tea Olive .... *Olea fragrans*
*California Privet .... *Ligastrum Japonicum*
*Euonymous .... *Euonymus Japonicus*

III—VINES.

There are no other plants which will make a building appear more a part of the landscape than vines. They cover up unsightly objects, clothing them with beautiful blooms and shimmering foliage. If the school house is of brick, stone or concrete, it may be completely covered with vines; if on the other hand, as most of them are, the building is of wood there are some few of the deciduous flowering vines that may be used to advantage.

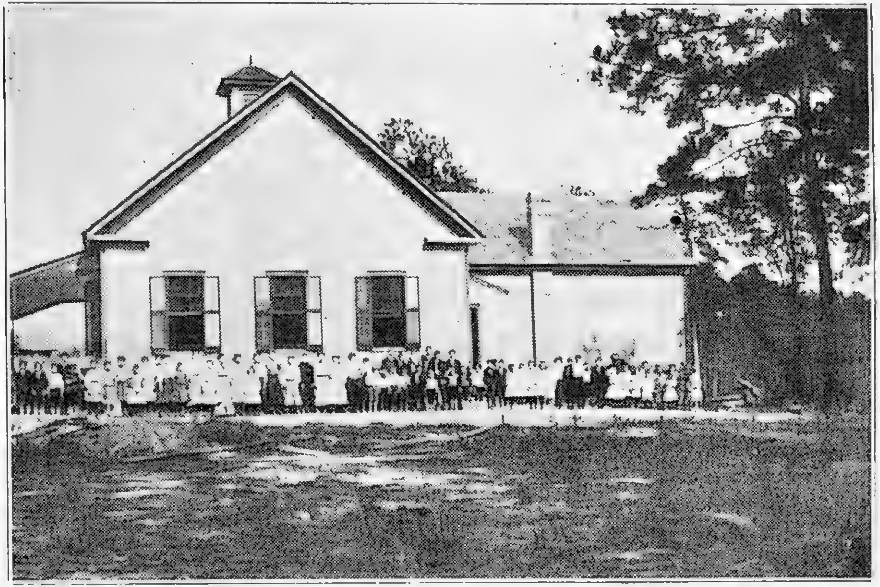
Nothing so much obliterates the objectionable character of a high board fence or unsightly object as vines. It is also in good taste and makes them more a part of the surrounding shrubbery and trees. As a rule, the care of vines is simple; they may be planted and allowed to grow as they will, except where they interfere with the windows; then they should be pruned back. If it should happen that in some out of the way corner there is a dead or dying stump of unnecessary height, such an object makes a good support for a vine. Those that may be used to advantage around the school building are as follows: Virginia creeper, the trumpet creeper, the wistaria, the ivy, the scuppernong and the honeysuckle.

The Virginia creeper, (ampelopsis quinquifolia) is especially well adapted to stone and brick structures. It also loses its leaves during the winter, and in that way cleans out all birds' nests and other litter that accumulates during the growing season. It is a fairly good grower.

The trumpet creeper (Tuoma radicans), one of our local runners, may be used to cover fences or stumps and even be trained up by the side of a wooden house. It has very pretty trumpet shaped flowers during the season and forms a large pod about the end of the summer. Incidentally it is a good vine to study botanically as it has well defined aerial roots.

The wistaria (wistaria frutescens and chinensis) is the king of

*Evergreen.



3. A CHANCE FOR WORK ON GROUNDS.

our flowering vines for early in the spring it gives a wealth of large purple blossoms that beautfy the most drear of landscapes, and tell of the coming of the glories of spring and summer. This vine is well adapted to the south; both varieties, the white and purple make equally good growth. It may be used to advantage over fences, stumps and all wooden structures, making a most beautiful protection for the various out-houses around the school grounds. Its foliage is also pretty and of a pleasing shade of green.

The ivy (Hedera helix), which is evergreen, is a very slow grower, and is adapted only to covernig stumps and stone or brick structures.

The scuppernong (Vitis rotundifolia), may be used to advantage over some of the outhouses or trained along the fences.

The honey-suckle (sonicera japonica and sempervirens), is about the easiest of any to grow and fills the atmosphere with sweetness when in bloom. It may be well used along wire fences, over old stumps, on trees, and even about the house and buildings.

When using vines avoid building a trellis for them and making them prominent in the landscape; they should not be grown as specimen plants, but should be used to cover things that are unsightly.

IV—FLOWERS.

Flowers are divided into two classes, the perennials and the annuals. As a rule, flowers are not desirable around the school ground as they are usually in the way. However, if there should be a nook, corner, or strip along the fence in some out of the way place where pupils go little, but which may be seen from some of the windows of the school house, it may be advisable to plant flowers there. They should, however, be segregated and not scattered all over the premises. Where the ball is apt to get into the flower bed or some boy is likely to fall over a tiny plant and be punished for the offense which was accidental, there grows a tendency to dislike such useless objects instead of a love for the beauties of nature. Where a school garden is cultivated, flowers can be grown to advantage, but in the general landscaping of the school ground it is best to confine flowers to little frequented spots.

The perennials are those that grow from year to year without replanting. Among them may be mentioned peonies, phlox, hollyhock, English daisy, cannas, poppies, violets, lilies, dahlias, narcissus, and some of the pinks. The perennials may well be banked against

the green of the shrubbery along the back fence or in some like place.

The annuals, consisting af nasturtiums, sweet peas, bachelor's button, sun flower, salvia, morning glory, gourd vines, and numerous other old-fashioned plants are dear to the heart of the true Southerner. They always speak of the colonial gardens the only type of landscape architecture that the South has given to the world, and which type is so fast disappearing from sunny Dixie.

LIST OF FLOWERS.

Perennials.

Peony	Paeonia
Phlox	Phlox
Hollyhock	Althaea rosea
Canna	Canna
Poppies	Paparer
Violet	Viola
Lilies	Lilium
Dahlias	Dahlia variabilis
Narcissus	Narcissus
Pinks	Dianthus plumarius and others

Annuals.

Nasturtiums	Troparolum
Sweet Peas	Lathyrus adoratus
Bachelor's button	Centanrea cyannus
Sun flower	Helianthus
Salvia	Salvia splendens
Morning Glory	Ipomoea
Gourd Vines	Gayenaria

Little need be said concerning the care of flowers for practically every school teacher is more or less interested in these plants. They hold in the family of decorative plants much the same position as the butterfly does among the insects. When a beginner first starts a collection of insects the butterflies make up the greatest portion of it because their flashing colors and large expanse of beautiful wings are attractive to the uninitiated: so also, when one begins to think of improving the grounds, flowers come in immediately for a large share of attention because they too give color to the landscape,

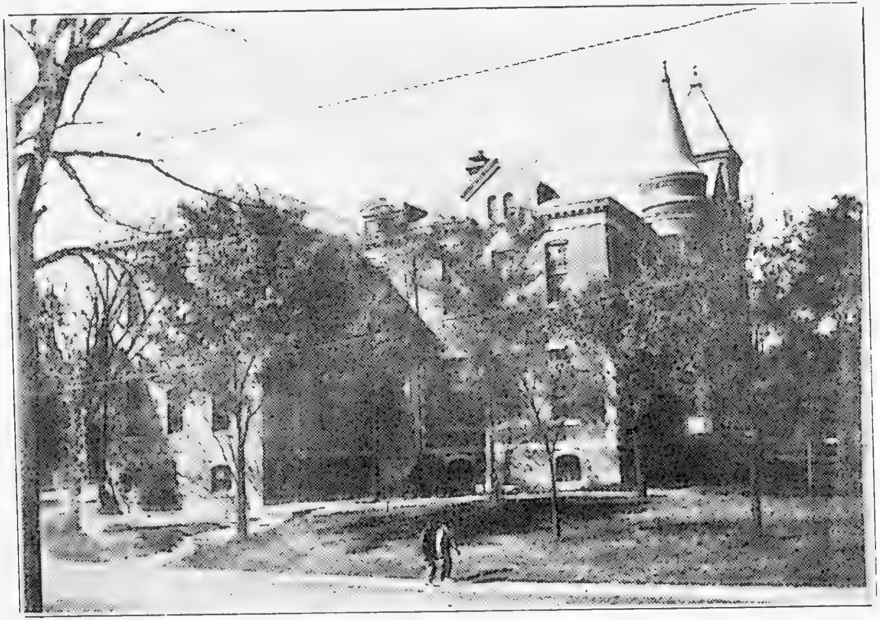
and the shrubbery and foliage are thought of later as they appeal to the more educated sense of beauty.

V—LAWNS AND PLAYGROUNDS.

There is quite a diversity of opinion as to the best type of playground for the school; whether it should be of grass, sand or gravel is a question that has bothered many school improvers. Each method has its advantages and disadvantages. The lawns will become trodden down by the tramp of many joyful feet, yet it is more beautiful than the bare playground of sand or cinders. The grass will become wet and ocasionally the children will have to stay off of it for days at a time or suffer from colds and wet feet. If a play ground is of clay and sand it may become muddy, and then the work of the janitor and the teacher is increased as unthinking feet track mud into the school room. If it is possible the playground may be of sand and gravel, that is probably the best type, especially for the boys' yard. These playgrounds, whether of grass or some other material, must be unobstructed. There must be room in them for games. They should not be cramped, for the spirits of youth need space in which to expand. A strip of grass may be grown along the fence or between the two playgrounds to serve as a dividing line, and then shrubs may be planted in this grass.

Some parts of the grounds where the boys or girls find enjoyment in sitting under the trees or lolling about may well be sodded down. Should the main playground be at the side of the building, then it might be well to have a lawn in front. On the other hand, should the playground be in front, the lawn should be placed at the back. Beaten and trampled down grass is not beautiful; it must be soft and green and deep and thick to add its full share of beauty to the landscape. Whether grass should be used at all, or whether it should compose the main part of the picture depends entirely upon circumstances. If the children are small and do not seem to enjoy rough games, it might be well to have the whole yard in a lawn, but as the pupils iencrase in size and age and the boys become more rough and find vent for energy in all kinds of manly sports, the poor grass stands but little show and it may well be replaced by some hard material as sand or gravel.

In making a lawn, we should first be careful to have the surface smooth. It is considered good policy to cultivate some fertilizer-giving crop, as peas, vetch or other legume upon the area to be grassed.



IMPROVEMENT POSSIBLE BY SHRUBS OR FLOWERS CLOSE TO BUILDING.

This crop should then be turned under, and if obtainable, a good coating of barn-yard litter may be turned under with it. This litter, however is apt to introduce weeds into the lawn, and if that much dreaded and deservedly condemned plant, "nut grass," should get into the lawn it is very, very hard to eradicate. After the surface has been well worked, levelled down, and rolled and rolled again, then a spike-tooth harrow or some other like implement of the farm may be run across the area to roughen it, and either in the fall or early spring the grass seed should be sown.

For localities in north middle Georgia and Alabama there seems to be no finer turf-making grass than the Kentucky Blue Grass, and it is well to sod the whole lawn to this. A mixture may be used if desired, but whatever is put on, do not be skimpey with the seed. If Blue grass alone is sown, 3 to 4 bushels should be used to the acre. After the first year, the lawn mower should be kept running; of course, it is impracticable to mow a school lawn as often as should be, but lawns that are cut every forty-eight hours are very superior to those gone over once in a week or two.

Below northern Georgia and Alabama the old reliable Bermuda grass must be depended upon. After the ground is put in good condition and levelled off, either in the fall or early spring the underground root stocks of Bermuda grass may be planted in rows two to two and one-half feet apart. If the ground is rich and the season good, with plenty of water, by the end of the year a fairly good lawn will have been secured. Bermuda will stand the rought feet, the tramping and ill uses probably better than any grass we have. It may be considered a weed in the field, but it is preeminently the lawn grass of the south. It also should be cut frequently to make it thicken up and form a good sod. Small areas of lawns, where money is available, may be sodded; that is, strips of sod taken from some old pasture: they should be cut about a foot wide and in long strips, as it is easy to roll them up and pile them on a wagon and then when laying them, they are easy to unroll again. The ground where the sod is laid should be roughed up to receive the roots: the sod should then be placed upon it and thoroughly tamped down and rolled. When possible, it is well to give it a good drenching as soon as it is planted. This latter method is more expensive, but is the quickest way of getting grass. Where it is desired to make playgrounds of gravel and sand in many sections it is only necessary to grub up the weeds and remove the stumps

and you have a fine sand-clay surface that makes an excellent pleasure yard. If it is desirable to work gravel into the surface and there is a creek near by from which the gravel can be easily procured, it would be well to roughen up the soil, haul the gravel upon it, and thoroughly scatter it then roll it in. For the average school probably the most serviceable and cheapest playground is the one of sand and clay, the natural surface of the earth.

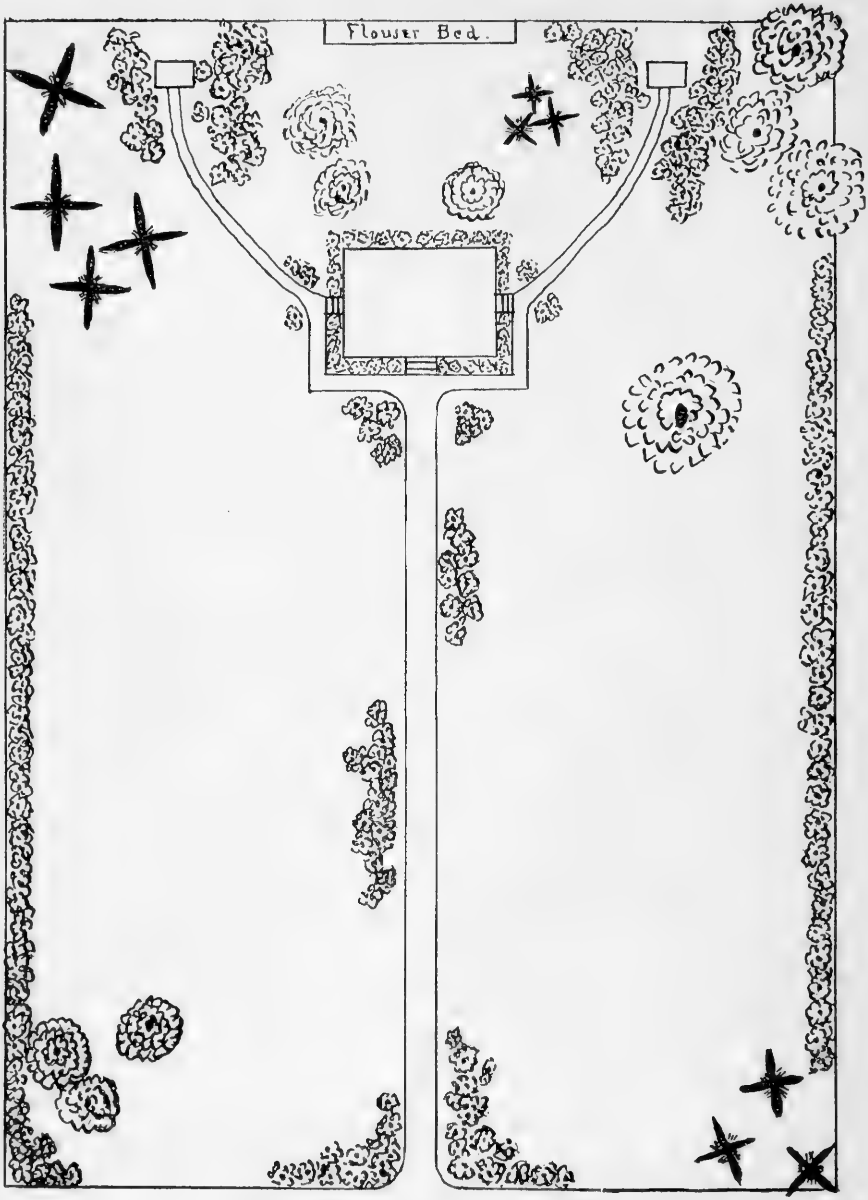
VI—GENERAL CARE OF GROUNDS.

Before planting a tree or shrub, it would be well for the teacher to draw a plan on paper. This plan should be handed down from teacher to teacher, so that even though the teaching force of the school was changed frequently, the plan would remain and eventually be worked out. All can not be done at one time. It is a process of evolution, and every teacher should start the wheel to rolling and let each succeeding one give it another push in the desired direction Finally all the school yards in our sunny land would be beautified with roses, wrapped with the purple and white of wistaria, and be sweet with the odors of many flowering shrubs and beautiful plants peculiar to our climate and southern homes.

After the plan is made and we are working to its ultimate completion, we will find that the plants which are first set out will need more or less care, and it is well to select those for planting around the school that are hard and tough. The trees should be kept free from nails, horse shoes, broken limbs and other objectionable objects. If a storm of sleet should come along and break the topmost boughs, they should be cut out, and where the wound is more than two inches in diameter a coat of good white lead paint should be applied to protect it from fungi and insects. In pruning or cutting a tree do not leave long unsightly stumps but cut the branches as close to the trunk as possible, and in a few years the wound will be unnoticed. Should a stub be left, it decays and finally eats to the heart of the plant and kills it.

The Shrubs need only to have the long objectionable branches cut away, or should they grow too tall, it may become necessary to prune them back within bounds, especially those around the house: otherwise their care is small unless it becomes necessary to make a light application of chemical fertilizer or a mulch of barn-yard litter now and then.

The Vines need only slight pruning to keep them also within the desired bounds.



PLAN FOR SCHOOL GROUNDS.

Flowers, especially the perennials, should be mulched with barnyard litter in the fall to feed and protect them from the cold of winter. Many of these die down to the ground and the old rotted remains should be removed and burned. They will come up again in the spring after the ground has been worked around them, and flower, lending their beauty to the landscape. The annuals have to be planted every year. Many of them are small growing plants, producing most beautiful blooms. The flower beds should be well fertilized and if the plants appear not to be doing well, a small application of quckly available food, as nitrate of soda, or some chemical fertilizer may be made. This should be worked into the ground with a hand rake or small hoe. Flower beds, of course, will need weeding and it is strange how many papers, letters and old exercises will collect in these beds and under the shrubs. These, of necessity, will have to be picked up, removed and destroyed. Where pupils take pride in their school and surroundings the trash is reduced to a minimum, but where the rules prohibit the throwing of paper and the like upon the ground, it is strange how much material will collect under the bushes.

We must control the pupils, we must improve the school through the love of the child, we must appeal to his pride and his love of nature. We can not force cleanliness and enjoyment of natural beauties upon. The best care of the school property lies in producing the correct attitude in the pupils toward the school.

The lawns should be frequently cut and where possible watered at least once a week. If they become yellow and seem to be doing poorly, then light applications of nitrate of soda should be made, and if they are so large that they can not be watered, we will have to wait for the rains to carry down the food, but if they should be small and water is available for applications, after the nitrate of soda is applied, water may be given. This, however, will seldom apply to any except city schools, as in the country we have to depend upon nature for our water supply. The greatest care of the grounds lies in keeping them clean. This may often be done by the janitor, but when it is possible it should be done by the pupils, for if they prevent or lessen the making of trash there will be but little to clean up.

The planting of the annuals may be done by classes or individuals. This, however, often brings up class and individual troubles, as in competition, the success of one and failure of another breeds bad blood among pupils as well as between men in after life.

To handle a district school well and through the use of plants and natural objects to give an interest in surroundings, to educate unresponsive children up to the enjoyment of the beauties of nature is not any easy thing to do. Yet, if all things in life were easy, there would be no use in living, and the teacher who can decorate the school grounds and protect tnem through the love of the child is doing a great deal towards the production of good citizens and men, who at some future time must bear the responsibilities of a greater America.

Let us hope that the future rural schools of this great country of ours will be beautified through the use of the natural and native trees, shrubs and flowers that grow at the very door-yards for the asking. They need only to be taken from the woodland surroundings and used to beautify the buildings in which are being produced the future American men and women.

Part VI.

HORTICULTURAL PRACTICE.

CUTTINGS.

Let us first consider the conditions necessary for the growth of cuttings. Having no roots, a cutting can take in but little moisture from the soil; nevertheless evaporation continues from its surface. In order, then, to start growth, the loss of water must be reduced to a minimum until the roots have taken hold of the soil. This reduction of evaporation brings up a discussion of climate. Warm, moist atmospheres reduce the loss of water from cuttings and make rooting an easy affair. In tropical climates many plants can be raised from cuttings which we would be unable to propagate by that method in this latitude. The necessary conditons for success from cuttings may be summed up as follows: Have an abundance of water; the ground warmer than the surrounding atmosphere and a relatively cool temperature of the air.

Deciduous hardwood cuttings should be allowed to mature on the plant; they should be taken during the dormant season and generally the best wood is that of last season's growth. With herbaceous plants immature or growing parts are often used. The wood used should be neither too old nor too young, too large nor too small. Large pieces have, usually, too much distance between the joints and those too small are apt to be immature. Cuts from the lower end of the branch usually root better than those from near the tip. Lateral branches are preferred to those near the top of the plant; often, however, the lower laterals are too large. A good length for a cutting is from six to nine inches; the greater the number of nodes on the cut the better the chances of success; two nodes with one internode will, though, often root without trouble.

In taking cuttings from herbaceous plants, that is, taking immature parts the leaves must be redced in size by cutting them in two or

removing most of them; it is not a good plan to remove all the leaves; simply reduce the number and size.

Hardwood cuttings may be taken any time after the plant becomes dormant. It is probably best to make them before the severe cold weather comes on; they can then be bound in bundles and buried, butt uppermost; after that it does not matter how cold it gets; the cuttings callous over at the butt and are in good shape to be planted next spring. In cutting, however, the lower end should be square and the cut should be made just below a bud; the top may be cut on a slant and allowed to extend some distance above the node. If made as above recommended it is an easy matter to distinguish between the top and bottom of the cutting at planting time.

For cuttings easily rooted any soil, except a stiff clay, will serve the purpose, but for those that are hard to root, as the conifers and herbaceous plants, a good clean sand is desirable and in many instances a necessity. Where cuttings are long they had best be planted on a slant; short ones may be put in straight, but taking it all in all the slant method is probably the best. With some kinds it is essential to have bottom heat. This may be secured by the use of a hot-bed where green-houses are not to be had. Where cuttings are set on a large scale in the field they should be from four inches to a foot apart in the row and the rows far enough apart to allow cultivation with a cultivator.

Plants commonly propagated by cuttings are as follows: Willows, figs, grapes, LeConte pears, Carolina poplars, pomegranates, etc. The cuttings from the above are usually easily rooted and may be set in the open or put out where the tree is desired to grow.

Herbaceous plants, as carnations, tomatoes, fuchsia, coleus, geraniums, etc., are also propagated by cuttings, but are harder to root than the hardwood ones mentioned first and are usually put out in green-houses devoted entirely to the business of propagation.

Besides cuttings of mature and growing parts above ground there are some plants propagated by root cuttings. Here are the approved methods for propagating citrus fruits.

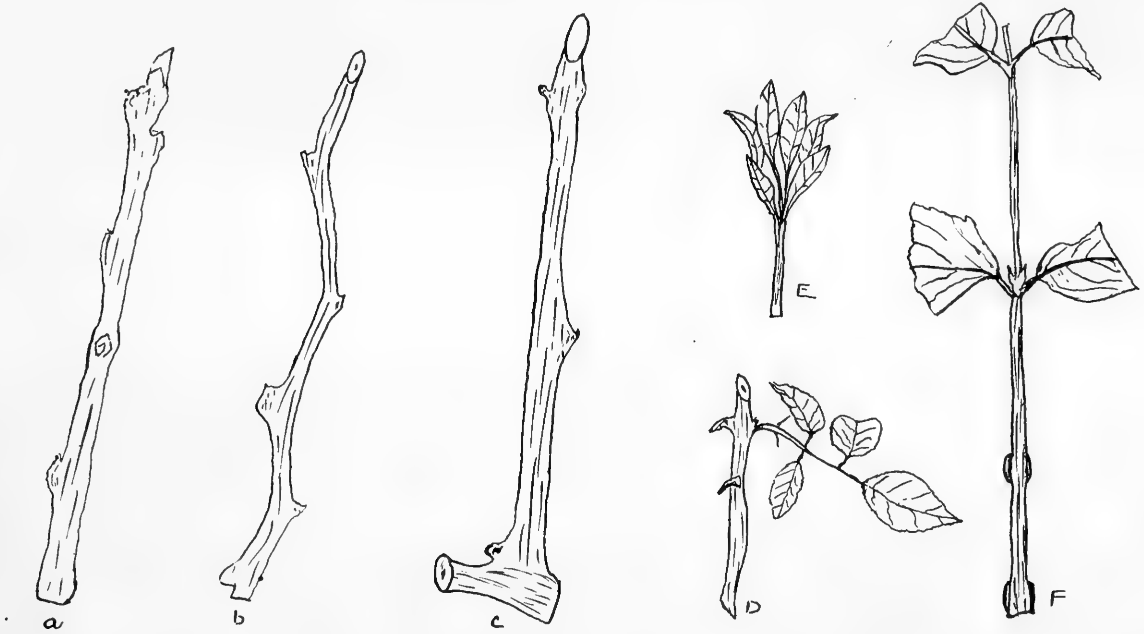
Orange—Named varieties are budded.

Lemon—Named kinds usually budded, but may be grown from cuttings set in open field. The ponderosa lemon is usually grown from cuttings.

Lime—Seeds, and some are budded.

Grapefruit—Seeds; may be budded upon orange or grapefruit stock.

Kumquat—Worked on orange stocks.



a-Fig cutting b- Grape. c- Grape-mallet form. D- Rose cutting one internode.

E & F - Herbaceous cuttings

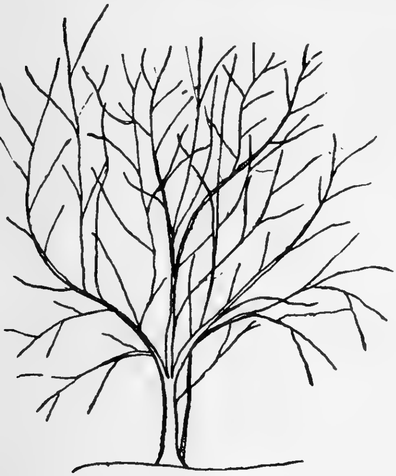
PRUNING.

Pruning is one of the six main orchard practices; the others are tillage, fertilizing, spraying, harvesting and marketing. Without paying close attention to all of these the orchard is apt to become an unprofitable investment. Tillage provides the general care of the soil and the conservation of the moisture; fertilization pertains to the food of the plants; spraying takes care of the diseases affecting the plants and fruits; harvesting pertains to the picking and packing, while upon marketing depends the profit or loss for the year. Pruning is that practice which removes surplus wood opens up the tree to the light, decreases the bearing area, thereby preventing a great deal of thinning in spring, and removes all dead or otherwise objectionable limbs. We might here stretch a point and call thinning a division of pruning, for after all, taking off surplus fruit is nothing more nor less than pruning.

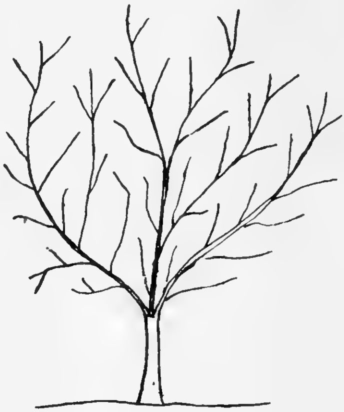
Why Prune—The best answer would probably be to give the reasons for and the effects of taking out wood. (a) Pruning is done to remove all crossing or otherwise interfering wood besides all dead and undesirable branches as those affected with blight of the apple or pear, black knot of the plum, or curl leaf of the peach. (b) By pruning some thinning is accomplished and the trees are prevented from bearing too heavy a load of fruit. (c) Too luxuriant a growth is checked by cutting out the wood and heading back the tree; checking growth induces fruitfulness, therefore pruning induces fruitfulness. (d) By opening up the head of the tree more sunlight is made available for coloring the fruit and holding diseases and pests in check; thinning out the top also gives a freer circulation of air, which is desirable in an orchard. (e) In the South trees are pruned and headed low to keep them within easy access of the pickers and to protect them from the heat of the sun. (f) Fruits on a pruned tree are usually larger than those on an unpruned one.

When Prune—It depends largely upon the plants to be worked with and the object of the pruning. Generally the best season is after the leaves have fallen and before the seeds begin to swell in the spring; just before or just after Christmas is probably the best time, though peaches and apples may be pruned later in the year than grapes. It is not advisable to prune grapes much after the first of February; the scuppernong and other rotundifolias should be pruned before Christmas, as they bleed profusely and if pruned later are apt to suffer materially. Summer pruning is advocated by some;

trees making an excessive growth may be pruned in the summer as the plant suffers considerably through the loss of its leaves and its growth will be greatly checked. Also, if one is cutting out blight it had best be done in the summer while it is easily perceptibl.e.



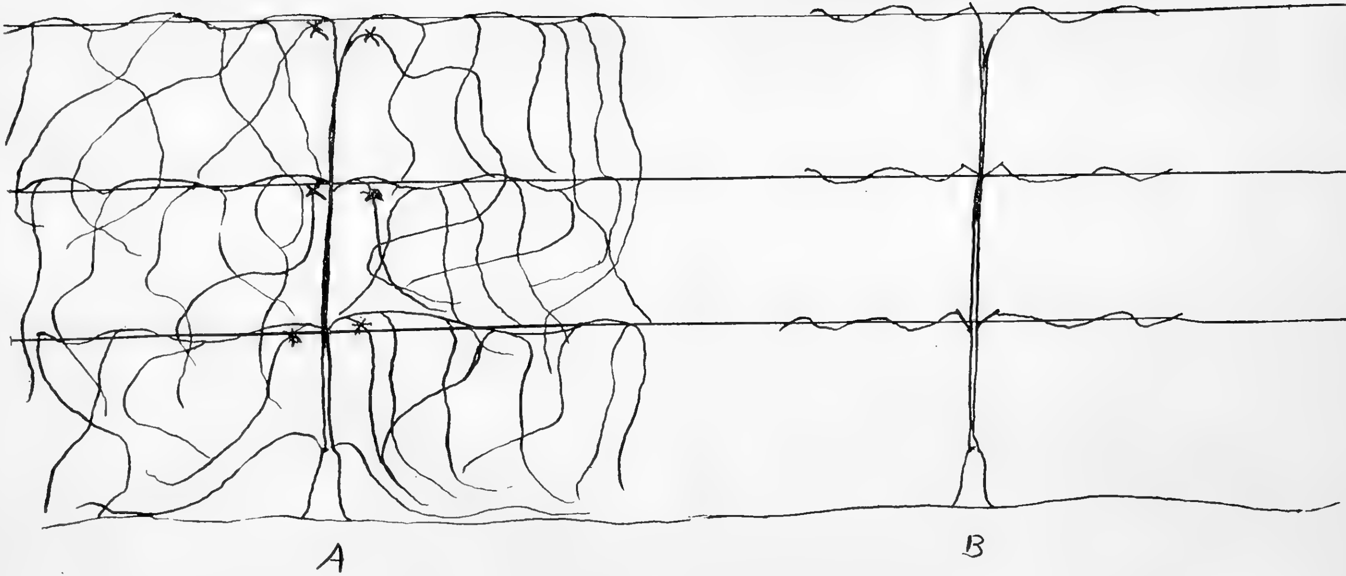
Peach Tree Unpruned



Same Pruned

How Prune—Remove all branches that cross or will at some future time interfere with one another; take out all surplus wood, water sprouts or suckers; dead, injured or badly diseased limbs, and in peaches cut back from a half to a third of the past season's growth; it is not advisable to cut back apples so severely. With grapes, cut back the past season's growth, leaving spurs with some three or four buds on them; the number of spurs left is determined by the type of training and the number of bearing canes desired the following season. With the small fruits thin out all the canes that are old or dead, leaving only those that will produce fruit the following summer.

In pruning old trees, or trees that have been left alone for several years, be careful not to take too much wood off the first time, as too heavy a cutting causes a severe shock which injures the tree. The size of the tree and the time it has been allowed to grow "**ad libitum**" will determine the time necessary to get it into shape. If the tree is large and has not been pruned in several years from a third to a



Grape vine pruned & unpruned. The canes marked (x) in A are the ones seen in B

half of the desired wood should be removed the first season till the desired amount has been taken out; it may take some three or four years to get the tree into good shape. It is well to remember that Rome was not built in a day, nor can an old tree be put back into shape in one season. Time and stick-to-it-iveness will work wonders in an old orchard and continual care will keep a young one in good condition.

GRAFTING AND BUDDING.

There is always great interest taken in the process of budding and grafting, especially by those who are unfamiliar with plant growth. They seem to think it one of the most wonderful things in the world that two pieces of wood will unite and form a p'ant. When the nature of plants is understood, there is really nothing more simple than grafting. It is possible for any one to perform the work successfully.

Grafting is simply the placing of a **scion** on, or into a **stock** so that a union is formed and thus the desired plant is propagated. Dr. L. H. Bailey divides the uses of grafting into three parts:

1—To perpetuate a variety.

2 To increase the ease and speed of multiplication.

3.—To produce some radical change in the scion or stock.

A definition or two may not be amiss; the **scion** is the vebetative part; it is to bring forth the variety that we wish to perpetuate. The **stock** is the portion which furnishes the root and nourishment for the plant.

To be a good grafter and make a success of the business, it is absolutely necessary to know something of the botany of the subject. The great point in grafting is to **have the cambium of the stock in direct touch with the cambium of the scion.** Unless this is the case, no union will take place and the time spent making the graft is thrown away. The cambium is the growing part of the tree; on its inner side it forms wood and on the outer it makes bark. The new cell formation takes place between the wood and bark. We also know that when a tree is injured it throws out a new tissue called a **callus.** This callus is the healing tissue of the tree as the scab is the healing tissue in man. Therefore, if you bring two wounded surfaces together they grow fast and, if the cambiums are touching, a connection is formed so that food can be taken up to the leaves and returned again to the roots.

Though grafting is a simple thing, there are some limits to it.

All trees and plants will not unite; there must be some similarity between them before they will grow together.

(1) Plants of different varieties and of the same species always unite. This means that an apple scion can be grafted onto an apple stock and will take or form a union.

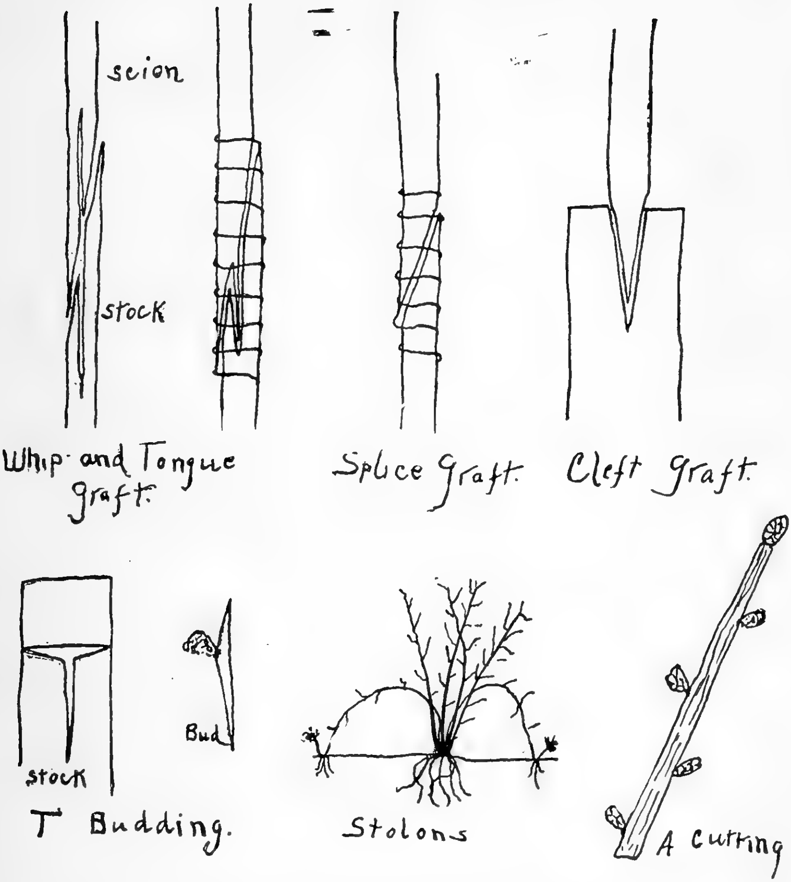
(2) Plants of different species but of the same genera almost always unite. That is, a peach can be grafted onto a plum and will usually take.

(3) Plants of different genera but of the same plant family, sometimes unite. This latter type of union is very seldom seen.

Let us now consider the three uses of grafting. **First**, to perpetuate a variety: It is well known that seed will not come true, so when we find a plant we wish very much to continue we have to do so by buds, as we can pretty well depend upon the bud producing the kind of plant that it was taken from. **Second,** to increase ease and speed of multiplicaton: We can graft a new variety into the top of an old tree and find out what kind of fruit it is going to produce long before it would bear fruit on its own stock. **Third,** to produce some radical change in the scion or stock: dwarf trees are obtained by grafting a rapidly growing scion into a slow growing stock, thus the scion is prevented from attaining its normal height. Stocks resistant to a given disease are used in sections where such troubles are prevalent. In many other ways adaptabilities and modifications may be secured by a judicious use of scion and stock.

There are three kinds of grafting: (1) Budding; (2) Scion grafting, and (3) Inarching or approach grafting. The latter is simply bringing two trees or twigs together, wounding them and tying the wounds one to the other. After a union has taken place, the top is cut away from the one desired for the stock and the stock cut away from the one wished for the scion and the graft is complete. This is th kind of grafting that is seen in the woods and is sometimes called a natural graft.

Budding is the inserting of a single bud into a stock, and after the bud has grown the original top is cut away and the bud allowed to form the top of the stock. Reference to the illustration will show how the bud is cut and how the work is done. There are two kinds, annular or ring-budding and T-budding. In the first, a ring of bark is cut out with the bud and the whole ring put onto the stock. In the T-budding a cut like a T is made on the stock and a bud with a bit of bark adhering to it is inserted and then tied in. Budding is done either in the fall or spring. The latter is called June budding with us.



GRAFTING, BUDDING AND CUTTINGS.

Scion grafting is divided into four parts: (1) Root grafting, when the scion is put into the root; (2) Crown grafting, when the scion is inserted at the crown of the plant; (3) Stem grafting, when the scion is inserted into the stem of the plant; that is, between the crown and the place where the limbs come out ,and (4) Top grafting, when the scion is put into the limbs of the tree. The methods of uniting the stock and scion are numerous, but those mainly used are the Whip graft, the Splice and the Cleft, all three of which are figured in the illustration. The first two mentioned are used extensively in root grafting, while the latter is mostly used for top working or top grafting.

Scions should be cut while trees are dormant and before severe freezing; they should be kept in moist sand in a cool place, and if root grafts are made, they should also be kept in sand until they have calloused over, then planted out in the open. Bud sticks are usually taken just about the time the budding is done and budding can be done at any time the bark will slip easily. Grafting is usually done during the dormant season, the scions being taken from last year's growth. At the time of grafting they are cut in lengths of four or more inches, there being from four to six buds on a scion. A scion with a terminal bud on it usually has the terminal cut off in order to induce a lateral growth. Bud sticks are also taken from the young growth; that is, the youngest growth on the tree at the time of cutting the sticks.

There is another use of grafting that often comes in handy. It is Bridge grafting. Often a tree is injured or girdled by mice or rabbits and it is possible to save it by bridging over the injured portions with scions sharpened at both ends and slipped under the bark of the stock. These scions make it possible for the sap to flow both ways in the tree and in a few years will have completely cured it of the injury. When grafts are made out of doors they should be covered with grafting wax to protect them until the union is made. All cions should be tied securely into the stock before the wax is put on.

There is no reason why one peach tree should not have several kinds of peaches on it, or why there should not be a rose bush in the yard that bears pink, red, white and yellow roses. Try grafting a little while and after some practice you will be able to get a good union most of the time.

Part VII.

CROP PEST DIRECTORY.

Crop pests are chiefly of two kinds:

1. **Insect Pests.**—Preparations for their destruction are known as "Insecticides."

2. **Fungus Diseases.**—Preparations for their destruction are known as "Fungicides."

INSECTS.

1. Biting Insects, (or Chewing Insects) which bodily devour vegetable tissue, subsisting largely on the foliage of plants. As they take the food material into their stomachs they may be readily destroyed by violent poisons, as the arsenites. To this class belong the Colorado potato beetle, most caterpillars, and in general, all leaf eating insects.

For them Paris green is the principal remedy, applied in liquid form by means of a spray pump, through the nose of a watering pot, or sprinkled with a broom, in the proportion of one ounce to ten gallons of water, or five ounces to the barrel of fifty gallons. When used on orchard trees, and especially on peaches, whose foliage is very sensitive, it should be reduced to four ounces and three ounces respectively.

In the dry form it may be mixed with thirty times its bulk of flour or lime, and, in default of a dust sprayer or blow-gun, dust on the plants in early morning, while the dew is on, through a meal sifter or a perforated can of any sort.

2. Sucking Insects. They have a sucking apparatus which they insert into the soft vegetable tissue and extract the sap. To this class belong all scale insects, plant lice and the "true" bugs, such as the pumpkin or squash bug, the harlequin cabbage bug, etc.

These insects cannot be reached through their stomachs. They must be destroyed through external applications. Kerosene, (preferably as an emulsion,) is found to stop their breathing pores and in-

stantly smother them, and in the past has been the chief weapon against these insects. Whale oil soap, though not so effective, is preferable whenever it can be substituted.

2. FUNGUS DISEASES.

Fungoid and bacterial affections are more numerous and widespread than insect pests, and usually more insidious. Effective remedies, while many, may, for all practical purposes be reduced to one: Bordeaux Mixture. This, if a fungus is capable of control, will generally prove more effective than any other fungicide. It may be superceded, when it is desirable not to stain the fruit, by Ammoniacal Carbonate of Copper. (Formula 10.)

Which Use?

The two necessary insecticides are Paris Greeen for all Chewing Insects, and Kerosene or its substitutes for Sucking Insects,—with the Lime Sulphur Wash for Scales. Additional or auxiliary preparations will be noted under the head of "Insecticides" in the next division.

The one universal Fungicide is Bordeaux Mixture, reinforced by Ammoniacal Copper Carbonate. Additional or auxiliary preparations are enumerated under head of "Fungicides."

The Lime Sulphur Wash is of almost equal value as Insecticide and Fungicide.

There are, of course, other minor materials and preparations, many of them; but, fortified by Bordeaux Mixture, and Paris green in the same preparation, for all Fungi and Chewing Insects, and with Kerosene or its substitutes, for sucking insects, and with Lime Sulphur Wash for Scales, the grower may confidently bid defiance to nearly every plant malady.

The fight is thus greatly simplified. The horticulturist need not attempt to identify the particular agency from which he is suffering injury. He may take it for granted that he is going to be attacked by both classes of insects,—Chewers and Suckers,—and that one or more, probably a varied assortment, or fungous affections will every season pay him their respects.

Therefore, forewarned is forearmed. He prepares his ammunition for the battle in the shape of a plentiful supply of Bordeaux with which he mixes five ounces of Paris green to every barrel of fifty gallons and sprays regularly, knowing that thereby he protects him-

self from all kinds of Fungi and Chewing Insects that may chance to visit him.

The Sucking Insects are more readily discoverable. On the appearance of aphids, (or plant lice), squash bugs, or any other form, he has his Kerosene Emulsion, (or Whale Oil Soap), with which to meet them. In the case of those pests which cannot be fought with kerosene or whale oil, on account of damage to the edibility or market value of the product, he must rely on Tobacco Infusion, Pyrethrum Decoction or Tobacco Pyrethrum Tea.

The chief remedy for Scale is Lime Sulphur Wash. A preparation of soluble oil known as "Scalacide" is now recognized as a very effective spray for San Jose Scale. It is thoroughly effective and particularly convenient.

FORMULAS.

1. Insecticides.

1. Paris Green,—Applied Dry:

Paris Green, 8 ounces
Flour, (or Lime), 15 pounds.

Sprayed:

Paris Green, 5 ounces
Lime, 6 pounds
Water, 50 gallons.

With Bordeaux:

Paris Green, 5 ounces
Bordeaux Mixture, 50 gallons.

For the Colorado Potato Beetle, Foliage Destroying Caterpillars, and all Chewing Insects. May be applied every ten days, or oftener if necessary. For orchard spraying in general, use four ounces to fifty gallons, instead of five ounces, and with peaches three ounces. Paris Green costs about twenty cents a pound retail. It is a violent poison; handle with care. Paragrene and Disparene are two other arsenites that are reliable and may be substituted in same proportion.

London purple is inferior to either, dangerous to foliage and is not recommended.

2. Arsenical Bran Mash.

White Arsenic, one ounce, or Paris green, one pound; syrup, two quarts; bran fifty to seven-five pounds. Thin the syrup with water, then mix well with the other materials and add enough more water

to make a wet but not sloppy mash; two or four pounds of dissolved sugar may be used instead of the syrup.

For grasshoppers, cut-worms and crickets. Scatter mash where grasshoppers are abundant, and for cut worms put a teaspoonful near the base of each plant. If on the first night after plowing the field the bait is scattered and left for two or three days, the cut-worms, having nothing else to feed on, will come to the surface, devour it, and be practically exterminated before the crop is planted. Scattered upon the cabbages it is good to destroy the cabbage worm. Wire worms may be poisoned to some extent by putting Paris green or White Arsenic on slices of Irish potato, or some similar vegetable, and using for a bait.

3. **Kerosene Emulsion:**

Kerosene, 1 quart

Whale Oil Soap, or other good hard soap, as Babbitt's, Ivory, or Glory, ½ pound.

Rainwater, or water known to be soft, 1 gallon.

Shave soap, dissolve it in the water, heat to almost boiling and then add the kerosene and churn through a cheap force pump until emulsified. Dilute with two and a half gallons of water, making one part kerosene to fourteeen parts of water. This produces about a seven per cent. mixture. Diluting with two gallons water about eight per cent. is obtained; nine per cent. with one and a half gallons, about eleven per cent. with one gallon, and some fifteen per cent. with two quarts. This is sufficiently strong for most purposes. Yet it is well to begin with the standard seven per cent. till its effects on foliage has been personally observed.

Mechanical Mixture.—Temporarily emulfisied by the Kero-Water sprayer. A lever regulates the per cent. of kerosene admitted to the nozzle. As the delivery, however, is not always exact, the Emulsion is decidedly preferable. Kero-Water Sprayers, indeed, if used at all, should be carefully watched.

Kerosene may be used for all Sucking Insects, Plant Lice, the softer Scales, Squash Bugs, etc., where the edibility of the product is not affected by the kerosene.

4. **Whale Oil Soap:**

Whale Oil Soap, 1 pound

Water, 6 gallons

Dissolve and spray for aphids on foliage in summer, or concentrate to one pound to three gallons water for wash for the softer scales in winter.

5. Tobacco Infusion:

Tobacco Stems, 1 pound
Boiling water, 4 gallons

Cool and strain. For Plant Lice, Flea Beetles, etc.

6. Pyrethrum Decoction:

Pyrethrum powder, 1 ounce
Water, (warm), 2 gallons

Dry application:

Mix one part, (by weight), of Pyrethrum with four parts of flour. Keep closed twenty-four hours before dusting, that the flour may be permeated by the essential oil of the Pyrethrum.

7. Tobacco Pyrethrum Tea:

Tobacco Stems, ½ pound,
Pyrethrum powder, ¾ ounces
Boiling water, 1 gallon

For obdurate cases of Plant Lice on young apple trees. Dip the affected branches in the tea.

2. Fungicides.

8. Bordeaux Mixture.

Copper Sulphate,, (bluestone), 4 pounds,
Quick Lime, 6 pounds
Water, 50 gallons

Dissolve the bluestone in two gallons hot water; strain through the copper sieve of the sprayer or through a gunny sack into a fifty gallon barrel. Slake the lime slowly in a wooden bucket and when ebullition is over dilute to a thick whitewash. Strain slowly into the bluestone in the barrel, stirring thoroughly. Fill the barrel with water. Always stir well before filling the sprayer. The cost of this mixture is less than one cent per gallon. For the first spraying before the buds swell, the lime may be omitted, and a simple bluestone solution prepared.

In case the mixture is not to be immediately used, it is well to make a stock solution, in separate barrels, of both bluestone and lime, one pound of each to the gallon of water. A gallon of either mixture will thus represent one pound of bluestone and one pound of lime, respectively, and the two may be readily combined in any desired proportion.

For application to peach foliage, (for brown rot, leaf curls, etc.,) a 3- 9-50 mixture, (three pounds bluestone, nine pounds lime, and fifty gallons water), must be used instead of the normal 4-6-50 formula.

reach foliage is extremely sensitive. When Paris green is combined with the Bordeaux it should not be stirred in until just before spraying.

9. Ammoniacal Copper Carbonate:

Copper Carbonate, 6 ounces
Aqua Ammonia, (strong, 26 degrees), 2 quarts,
Water, 50 gallons

Make a paste of the copper carbonate with water, dilute the ammonia with one and a half gallons water and stir in the paste until thoroughly dissolved, making two gallons stock solution. Keep the stock solution in a glass vessel stopped with glass or rubber, and on using dilute each quart with six gallons water.

Use whenever the Bordeaux stain would prove objectionable.

10. Formaldehyde (Formalin):

One pint to thirty gallons water.

For potato scab, and for purposes of general disinfection.

The tubers should be suspended in a gunny sack and immersed in a barrel of the liquid for two hours before cutting and planting.

When used for Smut in grain dilute to one pint to fifty galons water.

11. Corrosive Sublimate, (Mercuric Bichloride):

Corrosive Sublimate, 2 ounces
Water, 30 gallons

For Potato Scab. Soak as directed with Formalin, but for three instead of two hours. This is a violent poison, internally, and great care should be exercised in its use.

12. Lime Sulphur Wash:

Lime, (unslaked), 21 pounds
Sulphur, (flowers of), 18 pounds
Water, 50 gallons

Make a paste of the sulphur and stir same into fifteen gallons of boiling water. Add the lime and stir thoroughly while slaking. Boil violently for thirty-five or forty minutes, or until the mixture is a yellowish-green color. Dilute, before the boiling closes, to fifty gallons

For winter application for San Jose scale and also an effective fungicide for Plum Pocket, Leaf Curl, Black Knot, etc. The original Lime-Sulphur-Salt compound has now been almost entirely superceded by the foregoing, which proves equally effective and more economical.

13. Hellebore:

White Hellebore, 2 ounces.
Water, 10 gallons.

This may be dusted in powdered form. For Chewing Insects on cauliflower, or where ever it is not desired to risk the arsenites. Not so effective as the latter, but harmless.

14. Carbon Bi-Sulphide:

One teaspoonful to each cubic foot of bin space. For all weevils and insects attacking stored grains and seeds. Expose in open saucers or pour down gas pipes into piled grain.

This is a volatile liquid, whose fumes are heavier than air. When mixed with air the fumes are very explosive, and no fire of any kind should be brought near them. For fumigating a building containing growing plants, not more than one pint to one thousand cubic feet of space should be used. To destroy weevils in grain in tight bins, used about one pound to a ton of grain, or the liquid can be poured directly on the grain. If bins are somewhat open cover with a blanket. Fumigate from twenty-four to thirty hours, after which the bins should be thoroughly aired. No live stock should be left in a building which is being fumigated.

Ants nests may be destroyed by pouring the liquid into holes made by thrusting a sharpened stick into the top of the nests to the depth of ten or twelve inches. Close the holes and cover for an hour with a wet blanket. Sometimes the holes are made to a greater depth, and the operator, standing at some distance, lights gas with a flame at end of a pole. The explosion drives the gas into the furthermost parts of the nest.

APPENDIX.

TABLE I.

Vitality and Germination of Seed.

The first column gives the average time required for germination by the Stockbridge method of testing.* The second the average time for germination in the field. The third gives the vitality of seed or age after which it is not good.

NAME.	Days in Tester	Days in Field	Years of Life
Barley	2	5	3
Beans	3	6	3
Beets	5	9	6
Bluegrass	5	8	2
Buckwheat	4	7	2
Cabbage	4	8	5
Carrot	8	15	4
Celery	9	15	8
Clover	4	6	5
Corn (Field)	4	7	2
Corn (Sweet)	5	7	2
Cotton	10	15	8
Cucumbers	2	8	10
Egg Plant	6	10	6
Flax	2	4	5
Kohl Rabi	4	7	5
Lettuce	4	7	5
Melon (Musk)	4	6	5
Melon (Water)	4	6	6
Millet	4	7	5
Mustard	4	6	4
Oats	4	6	2
Okra	6	8	5
Onions	2	5	2
Orchard Grass	5	9	2
Parsley	5	8	3
Parsnip	8	15	2
Pea	5	8	3
Peanut	5	7	1
Peppers	7	11	4
Pumpkin	5	8	4
Radish	2	4	3
Rye	3	6	2
Spinach	5	8	4
Squash	4	7	5
Timothy	5	8	2
Tobacco	6	10	5
Tomato	5	9	4
Turnip	3	6	5
Wheat	3	6	40

*Put piece of board in shallow basin of water. Cover with cotton cloth so that edges hang in water. Lay 100 counted seeds on cloth and cover with second cloth. Count sprouted seeds.

TABLE II.

QUANTITY OF SEED REQUIRED.

Seeds Necessary to Produce a Given Number of Plants or Sow a Given Amount of Ground.

		Quantity per Acre.
Artichoke	1 oz to 500 plants	¼ lb.
Asparagus	1 oz. to 200 plants	5 lbs.
Beans, dwarf	1 quart to 150 ft. of drill	1¼ bushels.
Beans, pole	1 quart to 200 hills	½ bushel
Beet, garden	1 oz. to 200 feet of drill	10 lbs.
Beet, mangel	1 oz. to 150 feet of drill	6 bushels.
Cabbage	1 oz. to 3,000 plants	4 oz.
Carrots	1 oz. to 250 feet of drill	2½ lbs.
Cauliflower	1 oz. to 3,000 plants	5 oz.
Celery	1 oz. to 10,000 plants	4 oz.
Collards	1 oz to 2,500 plants	6 oz.
Corn, sweet	1 quart to 500 hills	8 quarts.
Cress,	1 oz. to 150 feet of drill	8 lbs.
Cucumbers	1 oz. to 80 hills	1½ lbs.
Egg Plants	1 oz. to 1,500 plants	4 oz.
Endive	1 oz. to 300 feet of drill	3 lbs.
Gourd,	1 oz. to 25 hills	2½ bushels.
Garlic, bulbs	1 lb. to 19 feet of drill	2 bu
Kale	7 oz. to 3,000 plants	6 oz.
Kohl-Rabi	1 oz. to 200 feet of drill	1½ lbs.
Leek	1 oz. to 250 feet of drill	4 lbs.
Lettuce	1 oz. to 250 feet of drill	3 lbs.
Melon, musk	1 oz. to 100 hills	1¾ lbs.
Melons, water	1 oz. to 25 hills	1* lbs.
Nasturtium	1 oz. to 50 feet of drill	10 lbs.
Okra	1 oz. to 50 feet of drill	10 lbs.
Onion Seed	1 oz. to 200 feet of drill	4 lbs.
Onion Seed	for sets	60 lbs.
Onion Seed	1 quart to 20 feet of drill	8 bushels.
Onion Sets	1 oz. to 250 feet of drill	5 bushels.
Parsnips	for transplanting	2½ lbs.
Parsley	1 oz. to 250 feet of drill	8 lbs.
Peas, garden	1 quart to 160 feet of drill	1* bushel.

Peas, field or cow peas	Broadcasted	2 bushels.
Pepper	1 oz. to 1,500 plants	4 oz.
Potatoes, sweet and Irish		9 bushels.
Radish	1 oz. to 150 feet of drill	8 lbs.
Spinach	1 oz. to 150 feet of drill	10 lbs
Summer Savory	1 oz. to 500 feet of drill	2 lbs
Squash, summer	1 oz. to 40 hills	2 lbs.
Tomato	1 oz. to 250 feet of drill	1* lbs.
Turnip	1 oz to 2,000 plants	4 oz.

TABLE III.

USUAL DISTANCES FOR PLANTING VEGETABLES.

Asparagus	Rows 3 to 4 ft. apart, 1 to 2 ft. apart in row.
Beans, bush	2 to 3 ft. apart, 1 ft. apart in rows.
" pole,	3 to 4 ft. each way.
Beet, early	In drills 12 to 18 in. apart
Cabbage, early	In drills 2 to 3 ft. apart.
" late	16 x 28 in. to 18 x 30 in.
" late	2 x 3 ft. to 2½ x 3½ ft.
Carrot	In drills 1 to 2 ft. apart
Cauliflower	2 x 2 ft .to 2 x 3 ft.
Celery	Rows 3 to 4 ft. apart, 6 to 9 in. in row
Corn, sweet	3 x 3 ft.
Cucumber	4 to 5 ft. each way.
Egg-Plant	1 x 1½ or 2 ft.
Lettuce	Drills 14 to 18 inches.
Melon, musk	4 to 6 ft. each way.
" water	10 to 12 feet each way.
Onion	In drills 18 in.
Parsnip	In drills, early kinds, usually in double rows, 6 to 9 in.
Peas	In drills, 1 ft. apart, late, in single rows, 1 to 3 ft. apart.
Pepper	15 to 18 in x 2 to 2½ ft.
Potato	10 to 18 in. x 2½ to 3½ ft.
Pumpkin	8 to 10 feet each way.
Radish	In drills, 10 to 18 in. apart.
Rhubarb	2 to 4 ft. x 4 ft.
Salsify	In drills, 1½ to 2 ft. apart.
Spinach	In drills, 12 to 18 in. apart.
Squash	3 to 6 ft. x 4 ft.
Sweet Potato	2 ft. x 3 ft. to 4 ft.

Tomato ....4 ft. x 4 to 5 ft.
Turnip ....In drills, 1 ½ to 2½ ft. apart.

TABLE IV.
NUMBER OF PLANTS OR TREES TO THE ACRE AT GIVEN DISTANCES.

Distance Apart	Number of Plants.
½ foot	74,240
1 foot	43,560
1½ feet	19,360
2 feet	10,890
2½ feet	6,969
3 feet by 1 foot	14,520
3 feet by two feet	7,260
3 feet by 3 feet	4,840
4 feet by 1 foot	10,888
4 feet by 2 feet	5,444
4 feet by 3 feet	3,629
4 feet by 4 feet	2,722
5 feet by 5 feet	1,742
6 feet	1,210
7 feet	889
8 feet	680
9 feet	435
10 feet	435
11 feet	360
12 feet	302
15 feet	193
18 feet	134
20 feet	108
25 feet	69
30 feet	49

TABLE V.
FRUIT TREES.

..Distances Apart. Time Required to Bear Fruit, and Longevity...

Apples........30 to 40 ft. each way 3 years. Good crop
1 year. Good crop
Apples, dwarf. 10 ft. each way ... in about 10 years .... 25-40 yrs.
Blackberry ...4 x 7 to 6 x 8 ft. ..... in 2 to 3 years. ...... 8-12 yrs.
Currant.......4 x 5 ft. .... 1 year. Good crop in
2 to 3 years .... 20 yrs.

Gooseberry	4 x 5 ft.	1 year. Good crop in 2 to 3 years.	20 yrs.
Orange, Lemon	20 x 30 ft. each way	2 to 3 years. Good crop 2 to 3 yrs later.	50 or more
Peach	16 to 20 ft. each way	2 years. Good crop in 4 years.	8-12 yrs.
Pears	20 to 30 ft. each way	3 or 4 years. Fair crop in 6-12 years.	50-75 yrs.
Persimmon	20 to 25 ft. each way	1 to 3 yrs.	25 to 40 yrs.
Plum	16 to20 ft. each way	3 yrs. Good crop in 5 to 6 years.	20-25 yrs.
Raspberry	3 x 6 ft.	1 year. Good crop in 2 to 3 years.	8-12 yrs.
Strawberry	1 x 3 or 4 ft.	1 yr. Heaviest crop usually in 2 yrs.	3 yr

TABLE VI.

Average Weight of Fertilizing Constituents in 1,000 Pounds of Garden Crops.

MARKETABLE CROP.	ONE THOUSAND POUNDS CONTAINS:			
	Nitrogen, lbs.	Equiv. to Ammonia lbs.	Available, Phos. Acid lbs.	Potash, lbs.
Asparagus	2.9	3.52	0.8	2.9
Beets	2.4	2.91	0.9	4.4
Cabbages	3.8	4.61	1.1	4.3
Cauliflower	1.3	1.58	1.6	3.6
Cucumbers	1.6	1.94	1.2	2.4
Lettuce	2.3	2.79	0.7	3.7
Onions	1.4	1.70	0.4	1.0
Potatoes, Irish ...	2.1	2.55	0.7	2.9
Tomatoes	1.6	1.94	0.5	2.7
Turnips	1.8	2.19	1.0	3.9
Compare with—				
Wheat (grain) ..	23.6	28.7	8.90	6.10
Corn (grain) ...	18.2	22.1	7.00	4.00

TABLE VII.

Average Percentages of Constituents for Fertilizers for Garden Crops.

CROP.	CONTAINING:			
	Nitrogen	Ammonia	Available Phos. Acid	Potash
Beans, Snap	2.47	3	7	7
Beets	4.94	6	5	8
Cabbages	4.94	6	5	7
Cauliflower	4.94	6	5	7
Celery	5.77	7	5	8
Cucumber	4.94	6	5	7
Egg Plant	4.12	5	6	7
Lettuce	4.94	6	5	8
Melons, Musk	4.94	6	5	7
Melons, Water	4.94	6	5	7
Onions	4.12	5	5	8
Peas	2.47	3	7	7
Potatoes, Irish	4.94	6	7	8
Potatoes, Sweet	2.47	3	7	8
Radishes	4.12	5	7	8
Spinach	4.12	5	8	6
Tomatoes	4.12	5	6	7
Turnips	4.12	5	7	8
Beans, Lima	2.47	3	7	7

TABLE VIII.

Average Percentage Composition of Fertilizinv Ingredients.

INGREDIENTS	CONTAINING: Nitrogen.	or Ammonia	Phosphoric Acid.	Potash
FURNISHING NITROGEN PRINCIPALLY:				
Sulphate of Ammonia, 98 per cent...	20.	24.	....	....
Nitrate of Soda, 97 per cent.	16.	19.	....	....
Dried Blood	13.	16.	5.	....
Fish Scrap	8.2	10.	8.†	....
Tankage	7.4	9.	11.†	....
Cotton Seed Meal	7.	8.50	2.5*	1.8
FURNISHING POTASH PRINCIPALLY:				
Kainit	......	....	....	12.5
Sylvinit	......	....	....	....
Sulphate of Potash, High Grade (96 per cent.)	......	....	....	52.
Sulphate of Potash, Magnesia	......	....	....	....
(Double Manure Salt)	......	....	....	27.
Muriate of Potash	......	....	....	50.
Wood Ashes (Hard Wood, Unleached)	......	....	2.	5.
Cotton Seed Hull Ashes	......	....	9.	23.
Tobacco Stems	1.5	1.80	.75	5.
FURNISHING PHOSPHORIC ACID PRINCIPALLY:				
Acid Phosphate	......	....	10-14*	....
Disolved Bone	......	2.	14.*	....
Bone Meal	......	4.	23.‡	....
Bone Black	......	....	28.	....
Bone Ash	......	....	35.	....
Dissolved Bone Black	......	....	16.*	....

* Available Phosphoric Acid.

† Contains 4 per cent. Available Phosphoric Acid.

‡ Contains about 10 per cent. Available Phosphoric Acid.

TABLE IX.

Average Yield of Garden Crops, and Weight of Fertilizing Constituents contained in them which is Annually Removed from the Soil.

CROP.	MARKETABLE PRODUCT.	CONTAINING: Total, Weight, lbs.	Nitrogen lbs.	Or Ammonia lbs.	Phos. Acid, lbs.	Potash lbs.
Asparagus	....	4,000	11.6	14.08	3.2	11.6
Beans, Lima	30 bushels, dry, at 60 lbs.	1,800	....	.....	....	....
Beans, Snap	150 crates at 40 lbs.	6,000	....	.....	....	....
Beets (Early)	100 barrels at 180 lbs.	18,000	43.2	52.38	16.2	79.2
Cabbage	200 barrels at 150 lbs.	30,000	114.0	138.30	33.0	129.0
Cauliflower	1,000 heads at 4 lbs.	4,000	5.2	6.32	6.4	14.4
Celery	3,000 heads at 2 lbs.	6,000	....	.....	....	....
Cucumbers	1,000 bushels at 70 lbs.	70,000	112.0	135.80	84.0	168.0
Egg Plant	130 barrels at 200 lbs.	26,000	....	.....	....	....
Lettuce	40,000 heads at ¾ lb.	30,000	69.0	83.70	21.0	111.0
Melons, Musk	5,000 at 2 lbs.	10,000	....	.....	....	....
Onions	800 bushels at 60 lbs.	48,000	67.2	81.60	19.2	48.0
Peas, Green	175 1-bu. crates at 50 lbs.	8,750	....	.....	....	....
Potatoes, Irish	80 barrels at 175 lbs.	14,000	29.4	35.70	9.8	40.6
Potatoes, Sweet	300 bushels at 60 lbs.	18,000	....	.....	....	....
Spinach	100 barrels at 60 lbs.	6,000	....	.....	....	....
Tomatoes	100 bushels at 70 lbs.	7,000	11.2	13.58	3.5	18.9
Turnips	500 bushels at 65 lbs.	32,500	58.5	71.18	32.5	126.8
Compare with—						
Wheat (grain)	15 bushels at 60 lbs.	900	21.2	25.83	8.01	5.5
Corn (grain)	20 bushels at 56 lbs.	1,120	20.4	24.75	7.8	4.5